INSECTS OF WESTERN NORTH AMERICA

A MANUAL AND TEXTBOOK FOR STUDENTS IN COLLEGES AND UNIVERSITIES AND A HANDBOOK FOR COUNTY, STATE AND FEDERAL ENTOMOLOGISTS AND AGRICULTURISTS AS WELL AS FOR FORESTERS, FARMERS, GARDENERS, TRAVELERS, AND LOVERS OF NATURE

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BY

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TO

My Teachers and Friends

Dean CHARLES FULLER BAKER

and the late

Doctor ALBERT JOHN COOK

PREFACE

Since the appearance of the second edition of "Injurious and Beneficial Insects of California," in 1915, the writer has been working towards the completion of a more comprehensive work on the insects of western North America. This effort has been greatly encouraged by the very large number of requests from many local sources and the real needs of numerous western students who at present lack such a book on general western entomology.

In addition to the first-hand knowledge and experience in this large area, an attempt has been made to glean from the extensive and very complete western entomological libraries, such information as might be useful to those interested in insects, not only in this region, but throughout America and indeed the whole world. Many of our most important pests have been introduced from foreign lands which are now sending students to our institutions to study these cosmopolitan and similar species. In order to accomplish this wider aim the author has reviewed carefully all the available literature dealing with western insects. Accordingly, the publications of the Bureau of Entomology of the United States Department of Agriculture, the Agricultural Experiment Stations, State Universities, Colleges, Academies of Sciences, Natural History Societies, etc., as well as the entomological journals, periodicals and books, both American and foreign, which have had a part in the extensive development of western American entomology, have been consulted, in addition to the hundreds of synopses, monographs and other papers as indicated in the bibliographical footnotes.

Besides the compiled data, there are included numerous hitherto unpublished notes by the author and by many of those who have reviewed the manuscript.

The classification adopted is an attempt to reconcile the modern ideas with the more conservative ones and in so doing to give sufficient synonymy and other information to enable the students of all schools of nomenclature to find the information contained within these pages. The author frankly admits his inability to arrive at an altogether satisfactory arrangement in many of the orders, but hopes that the readers will be more interested in the real object of the work, which is to give specific information, both economic and technical, rather than to produce a critical treatise on classification and nomenclature.

The scope of this work is intended to cover the large western area bounded on the north by the northern limits of Alaska, on the east by the Rocky Mountains, on the south by Mexico and Lower California, and on the west by the Pacific Ocean. Within this area are included the States of New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, Arizona, Nevada, California, Oregon, Washington and British Columbia and Alaska. Many of the species extend into Texas, Oklahoma, Kansas, Nebraska and the Dakotas on the east, into Alberta and Manitoba in the north and into Mexico and Lower California on the south. It is remarkable that so many species are common to this vast territory and the study has shown

that a work covering the same has more unity than the author anticipated at the outset. The middle-western and eastern entomologists may also be interested to check up on the large number of species which are common to the whole country and to note the many regional forms of the same or closely related species: to illustrate, the two common cucumber beetles, *Diabrotica duodecimpunctata* (Fabr.) and *D. vittata* (Fabr.) which extend westward to and beyond the Rocky Mountains, and both replaced in the far west by *Diabrotica soror* Lec. and *D. trivittata* (Mann.).

To conserve space, it has been necessary to omit altogether many important keys to species and genera, as well as descriptive material. In the original manuscript all natural enemies were listed under their respective hosts as well as in their own proper groups, which duplication, although of great service to the reader, was omitted in order to reduce the size of the book. Lack of space to include a more comprehensive host plant index is also regrettable, but it is believed that by means of the very complete general index most of these shortcomings may be surmounted.

To have attempted such a work single-handed would have limited the value of the book very greatly, hence the writer early decided to enlist as much help as possible in order to make it truly representative of western entomology. Accordingly, as each portion of the manuscript was completed, copies were sent to specialists throughout the country for revision. A most hearty response and complete coöperation followed. It is regrettable that it was not possible to carry this coöperation further. To my associates at the University of California I owe most, including E. C. Van Dyke, W. B. Herms, S. B. Freeborn, H. H. P. Severin and C. W. Woodworth. Those who have made large contributions in special groups are G. F. Ferris, Stanford University, in the *Mallophaga*, *Coccidæ*, *Anoplura*, *Pupipara*, and who has made many valuable general suggestions and given much sound advice; Nathan Banks, Museum of Comparative Zoölogy, Harvard University, in *Arachnida* and *Neuroptera;* H. E. Ewing, in the *Arachnida;* J. W. Folsom, in the *Collembola;* A. N. Caudell, U. S. National Museum, in *Orthoptera;* J. G. Needham, Cornell University, in the *Neuroptera*, *Ephemerida*, *Odonata*, *Mecoptera*, and *Trichoptera;* C. K. Sibley, Cornell University, in the *Trichoptera;* E. P. Van Duzee, California Academy of Sciences, in *Homoptera*, *Hemiptera* and other orders; A. C. Baker, U. S. Bureau of Entomology, in *Aphididæ* and *Aleyrodidæ;* P. W. Mason, U. S. Bureau of Entomology, in *Aphididæ;* E. C. Van Dyke, University of California, in *Coleoptera;* J. M. Aldrich and J. R. Malloch, U. S. National Museum, in *Diptera;* S. B. Freeborn, University of California, in *Culicidæ;* Harrison G. Dyar and August Busck, U. S. National Museum, in *Lepidoptera;* S. A. Rohwer, A. B. Gahan, and R. A. Cushman, U. S. National Museum, in *Hymenoptera;* H. S. Smith and P. H. Timberlake, University of California, in parasitic *Hymenoptera;* A. C. Kinsey, University of Indiana, in *Cynipidæ;* M. R. Smith, University of Illinois, in *Formicidæ*. To all these helpers sincere appreciations are herein extended.

The illustrations form an important part of the work. Although original material was available throughout, it was thought that the book would be more representative if some of the typical illustrations of other workers were included. Dean E. D. Merrill of the California Agricultural College and Experiment Station has kindly loaned the cuts for the illustrations

used which have previously appeared in the bulletins of this station; and Director G. H. Hecke, California State Department of Agriculture, has loaned the numerous cuts of former illustrations in the Monthly Bulletin and "Injurious and Beneficial Insects of California." Most of the original photographs were made by W. C. Matthews, Scientific Illustrator for the University of California, but quite a number are by the author, and others as designated. Drawings were made by a number of students and illustrators, B. Y. Morrison, Miss M. H. Langtree, Miss Mildred Bennett, Miss M. H. Swift, Mrs. E. L. Essig, by the author, and by several whose names are now unknown.

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CHAPTER I

ARTHROPODA (Phylum)

Arthropods

The members of this phylum are characterized by having a hard exoskeleton; the body composed of a number of similar segments arranged longitudinally; paired and jointed appendages; nearly perfect bilateral symmetry; absence of cilia; central nervous system consisting of a dorsal pair and a ventral double chain of ganglia; generally striped muscles; mouth and anus at opposite ends of the body; respiratory system consisting of gills, book-lungs or tracheæ; and usually separate sexes.

This phylum includes more species than all the other phyla of the animal kingdom together. It is of great importance to the human race as a source of food and useful commodities, while also within its category are serious pests and carriers of diseases.

The multitudinous members of this great group are to be found everywhere: in water, soil, and air, and have become adapted to every conceivable condition. They are arranged into a number of classes which may be separated as follows:

KEY TO CLASSES [1]

1. Body not segmented; worm-like; with many unjointed legs; air breathing tropical animals living under stones or bark in moist places. (Slime Slugs). **Onychophora**
   Body distinctly segmented, except in a few specialized forms 2

2. Without antennæ 3
   With one pair of antennæ 9
   With two pairs of antennæ; at least five pairs of legs; aquatic respiration. (Crabs, Lobsters, Sowbugs, etc.) .... **Crustacea** p. 2

3. With well-developed aquatic respiratory organs; marine animals. (King Crabs) .... **Palæostracha**
   With well-developed aërial respiratory organs or without distinct respiratory organs 4

4. With well-developed aërial respiratory organs 5
   Without distinct respiratory organs 6

5. Body elongate and flattened or thysanuriform (**Eosentomidæ**). Very small animals living in damp leaf mold or humus .... **Myrientomata**
   Body not elongate and flattened or thysanuriform. (Scorpions, Spiders, Mites, Ticks, etc.) .... **Arachnida** p. 8

6. Legs distinctly segmented 7
   Legs not distinctly segmented 8

[1] Modified from J. H. Comstock, A. Berlese, A. Handlirsch and other authors.

7. With six pairs of legs, three pairs of thoracic and three pairs of vestigial abdominal legs (**Acerentomidæ**) (See 5) .... **Myrientomata**
   With four or five pairs of ambulatory legs; abdomen vestigial. Small marine spider-like animals, occurring on seaweeds and rocks along the shores and in deep water (Pycnogonids) .... **Pycnogonida**

8. Adults with four pairs of legs. Minute mite-like animals living in damp places or in fresh and salt water. (Tardigrades or Bear Animalcules) .... **Tardigrada**
   Adults legless, immature forms with two pairs of legs. Specialized worm-like or fluke-like animals which are parasitic on one or more animals. (Pentastomids or Linguatulids) .... **Pentastomida**

9. Wingless and with more than three pairs of legs 10
   Winged or wingless and with but three pairs of legs in the adult form. (Insects) .... **Hexapoda** or **Insecta** p. 51

10. With apparently two pairs of legs on some of the body segments. (Thousand-legged Worms) .... **Diplopoda** p. 4
    With but one pair of legs on each body segment 11

11. Antennæ simple, not branched 12
    Antennæ branched; minute white centipede-like animals living under damp leaves and stones or in damp humus. (Pauropods) .... **Pauropoda**

12. Head with a Y-shaped epicranial suture; tarsi each with two claws; opening of reproductive organs ventrally and anteriorly. (Symphylids or Garden Centipedes, ... **Symphyla** p. 5

    Head without a Y-shaped epicranial suture; tarsi each with a single claw; opening of reproductive organs near posterior end. (Centipedes) .... **Chilopoda** p. 7

CRUSTACEA (Class)

Crabs, Lobsters, Shrimps, Sowbugs, etc.

The *Crustacea* is a very large class of aquatic animals, the greater number of which are marine. A few are terrestrial of which some of the members of the order *Isopoda*, notably the pillbugs, sowbugs or wood-lice of the Family **Oniscidæ**[1] are occasionally injurious. Although most of the sowbugs live on land they breathe by means of gills which must be kept moist. This accounts for their frequenting wet and damp places and for their greatest periods of activity occurring in the wet seasons of the year.

The dooryard sowbug, *Porcellio lævis* Koch (Fig. 1), is the common species met throughout the country. The adults are regularly oval, almost twice as long as wide, 8 x 15 mm., with a convex hard exoskeleton composed of a number of articulating plates; dark gray or slate color above with two indefinite pale longitudinal lines and paler beneath; 7 pairs of legs; antennæ nearly half as long as the body; averging from ¼ to nearly ½ inch in length. The young are very much like the adults except smaller and much paler in color. Little is known regarding the life history; there appears to be but one brood a year. Until ready to feed, the young are carried about in a ventral receptacle formed by the modified anal plates of the female. All stages are nocturnal and feed largely on decayed vegetable matter, but also attack young tender plants in greenhouses, lathhouses, and gardens, and do considerable damage.

[1] H. Richardson, *Mon. of the Isopods of N. A.* Bul. 54, U.S. Nat. Mus. 1905, p. 592.

Young plants of all kinds, including flowers, vegetables, strawberries, mushrooms, and forage crops are attacked.

Houses may be rid of sowbugs by thoroughly drying out the basements and making living therein impossible. Control in the greenhouses and gardens may be obtained by the use of poison baits consisting of slices of carrots or potatoes sprinkled with Paris green; the poison bran mash as recommended for grasshoppers and cutworms; or a special bait prepared

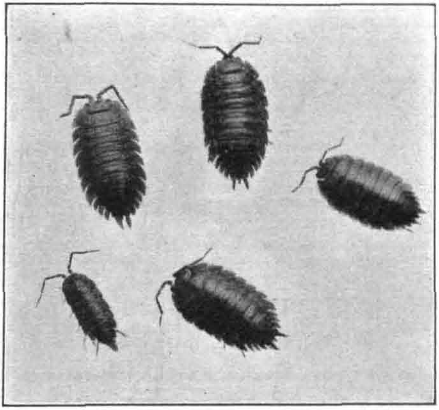

FIG. 1.—Sowbugs, *Porcellio lævis* Koch and *P. spinicornis* Say.

by mixing together 2 parts of rye flour, 2 parts of granulated sugar, and 1 part of Paris green. They can also be trapped under wet sacks, boards, or in overturned cans or flower pots filled with damp excelsior or straw.

The spiny sowbug, *Porcellio spinicornis* Say, is commonly associated with *P. lævis* Koch in California. It is smaller, but closely resembles it in appearance, except that the surface is covered with minute spine-like projections.

The scabby sowbug, *Porcellio scaber* Latreille, eats holes in the stems of artichoke plants and is quite abundant along the Pacific Coast from British Columbia to Lower California and is also widely distributed throughout the United States and the world. The body is ovate, 6 x 10 mm., and the whole surface is covered with small tubercles. The color is pale gray with dark spots, or nearly black.

The common pillbug, *Armadillidium vulgare* (Latreille), is similar to the preceding species, but more robust, darker, and rolls into a compact ball when disturbed. It is a cosmopolitan species recently established in the San Francisco Bay region of California, where it is often quite a pest in gardens, and more particularly in nurseries and greenhouses. Under glass it has been effectively controlled by using a mixture of Paris green and granulated sugar 1 to 5, placed on boards, cards, or on the railings around the beds.

The sand or kelp sowbug, *Alloniscus perconvexus* Dana, is a dull gray species mottled with black and white, 9 x 16 mm., which is abundant on the ocean beach of California feeding on kelp and other seaweeds.

DIPLOPODA (Class)

Millipeds, Thousand-legged Worms, Galley Worms [1]

These very interesting arthropods are characterized by two body regions, a head with a pair of short antennæ, and a body made up of a large number of similar cylindrical or somewhat flattened arthromeres each of

FIG. 2.—The common milliped, *Julus hesperus* Chamberlin, and typical work on planted seed potato.

which in most, though it appears distinct, represents two segments fused together and bears two pairs of short legs. The first four or five segments are not fused and bear each a single pair of legs. When disturbed millipeds coil in a characteristic attitude and may emit an offensive brownish

[1] R. V. Chamberlin, "New Western *Diplopoda*." *P. C. Jour. Ent. & Zoöl.*, 10, 1918, p. 9. Also *Ann. Ent. Soc. Am.*, 3, 1910, p. 233; Chas. H. Ballinan, "*Myriapoda of N. A.*" Bul. 46, U. S. Nat. Mus. 1893.

protective fluid. They are dwellers of the soil and rotten logs and are vegetarian in habits with comb-like jaws for scraping decaying vegetable matter and are seldom found except in damp places. The large majority of the species are of no general interest, but a few in nearly every locality are responsible for some damage to growing crops.

The common milliped, *Julus hesperus* Chamberlin,[1] (Fig. 2) is a small cylindrical, chestnut brown species, one-half inch long, which quite often attacks garden vegetables such as lettuce, cabbage, potatoes, dahlias, and other plants in California. *Julus hortensis* Wood is reported injurious to vegetables in British Columbia.[2] It also occurs in the middle West.

Millipeds have never been of sufficient importance to necessitate control measures.

SYMPHYLA (Class)

Symphylids, Garden Centipedes

The members of this class look like minute white centipedes, from which they are separated by having only twelve pairs of legs in the adult and fewer in the young; the absence of eyes; not more than three pairs of jaws and no maxillipedes; and the genital apertures in the venter between the fourth pair of legs. The writer has repeatedly caused the adults to spin a delicate web, apparently from the cerci, upon which they swing from place to place. They live in damp places rich in vegetable mold, in manure piles, in peaty soils or those rich in humus, where they may prove to be serious pests.

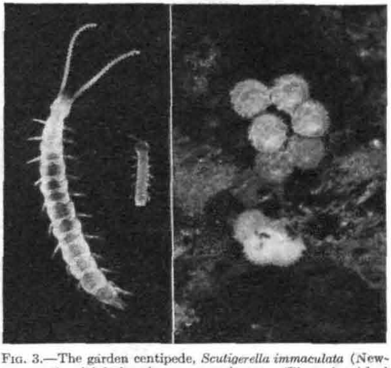

FIG. 3.—The garden centipede, *Scutigerella immaculata* (Newport). Adult female, young and eggs. (Photo furnished by F. H. Wymore.)

The garden centipede, *Scutigerella immaculata* (Newport) [*S. californica* (Woodworth)] (Fig. 3). The adults are delicate, pure white, very active, and exceedingly small creatures scarcely one-fourth of an inch long. The antennæ are well developed and kept constantly in motion. The symphylids traverse the soil freely through cracks, crevices, and small tunnels

[1] R. V. Chamberlin, *Can. Ent.*, 46, 1914, p. 314. Orig. desc.
[2] *Proc. B. C. Ent. Soc.* 1914, p. 18.

resulting from the decaying roots of plants. They inhabit only damp soil and are most abundant and injurious in the early spring, attacking planted seeds (Fig. 4), and the young shoots as they push through the soil. Beans, peas, asparagus, and beets are known to be injured by them. In the peaty soils of California, where canning-asparagus is grown, the garden centipede is the most serious pest. It attacks the tender white shoots before they push through the surface of the soil and completely perforates them with small burrows which soon become discolored, render-

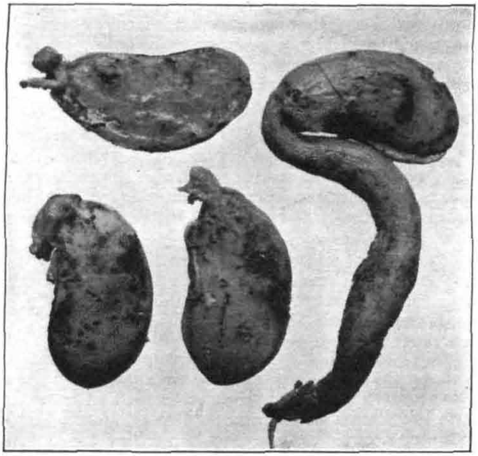

FIG. 4.—Work of the garden centipede on germinating lima beans.

ing the product unfit for canning and even killing the seed-bearing shoots which are allowed to appear in midsummer by girdling them below ground with its innumerable burrows. During the late summer and fall the centipedes follow the soil moisture as it recedes from the surface and return as it rises again in the winter. Injury to sugar beets and various truck crops has been observed in Colorado, Utah, Oregon, and California. The pest occurs in many parts of North America and in Europe.

In the asparagus fields the most efficient means of control is flooding for a period of from three to four weeks in the winter. Where flooding cannot be practiced there is yet no satisfactory means of dealing with the pest.[1]

[1] F. H. Wymore. "Biology and Control of the Garden Centipede." *P. C. Jour. Ent. and Zoöl.*, 16, pp. 73–88, 1924. (Good Bibliography).

CHILOPODA (Class)

Centipedes, Geophilids, and Lithobians

The members of this class are generally flattened, many segmented, long-bodied animals with moderately long antennæ and one pair of legs to a body segment; four pairs of jaws, one pair of which is modified into poison fangs (maxillipedes); a pair of eyes, each composed of a group of ocelli, or, rarely, a pair of compound eyes. They are usually swift runners, inhabiting the soil and may be found under rotten logs, stones, boards, and so forth, and are predaceous on small animals such as earthworms, snails, and insects, which they readily kill with the maxillipedes. Their bite is painful to human beings, but is seldom serious. As a whole they may be considered beneficial because of the numbers of pests they devour.

There are many species of different sizes and colors to be found almost everywhere. **The house centipede,** *Cermatia forceps* (Raf.) (*Scutigera forceps* Raf.), is an interesting and unusual form with rather short body, one inch long, and with fifteen pairs of very long legs; long antennæ and a pair of compound eyes. It inhabits dwellings and appears at night. So rapidly can it travel that one often just gets a glimpse of it as it traverses a floor or wall. It is so fragile that no damage can be done by it and much good is gained through its capture of flies, cockroaches, clothes moths, and other household pests. It is never in sufficient numbers to be really annoying.

The very long, somewhat delicate geophilids (Fig. 5), usually occur below the surface of the soil.

FIG. 5.—A geophilid; a very long centipede. (After Woodworth.)

CHAPTER II

ARACHNIDA (Class)

Scorpions, Harvesters, Spiders, Ticks, Mites, etc.

The members of this class are air-breathing arthropods with usually two body regions, the cephalothorax including a fused head and thorax, and the abdomen. The *Solpugida* show indications of three regions, while in the *Acarida* but one region is apparent. No antennæ appear in the adult forms; all have simple eyes; one pair of cheliceræ; one pair of pedipalpi; and usually four pairs of legs. The young of most of the mites and ticks are hexapod until after the first molt, when they acquire another pair, while the blister mites have but two pairs of legs. The organs of respiration are in the form of leaf-like external gills, or book-lungs containing many leaf-like plates or tracheæ similar to those of insects. The sexes are separate and there is no marked metamorphosis excepting in the *Acarida*.

In the Western States arachnids are varied and abundant. The large majority of the members are predaceous upon insects, other arachnids, and small animals, while not a few are serious plant and animal pests. The group is so closely related in the habits, work, and control of insects that we are giving it considerable space here. In fact we believe that arachnids cannot well be set aside in a comprehensive study of insect life in this region.

The class *Arachnida* is divided into various numbers of orders by different authors. The more important ones may be separated by the following key:

KEY TO ORDERS[1]

1. Abdomen distinctly segmented 2
   Abdomen not segmented 7
2. Abdomen with tail-like prolongation 3
   Abdomen without tail-like prolongation 4
3. Tail stout, armed with a sting at end .... **Scorpionida** p. 9
   Tail slender, without sting .... **Pedipalpida** p. 10
4. Palpi chelate .... **Pseudoscorpionida** p. 11
   Palpi not chelate 5
5. Abdomen constricted at base and narrowly joined to the cephalothorax **Pedipalpida** p. 10
   Abdomen not constricted at base and broadly joined to the cephalothorax 6
6. Legs very long and slender, body hairless, whole body fused together **Phalangida** p. 11
   Legs moderate; body hairy, appearing 3-segmented .... **Solpugida** p. 13
7. Abdomen constricted at base and joined to cephalothorax by a narrow stalk **Araneida** p. 14
   Abdomen fused with cephalothorax .... **Acarida** p. 16

[1] Adapted from J. H. Comstock, *Spider Book*, Doubleday, Page & Co., N. Y., p. 12, 1912.

SCORPIONIDA (Order)

Scorpions

This order consists of segmented arachnids having two body regions, a cephalothorax or prosoma and a broadly attached abdomen divided into a large anterior preabdomen or mesosoma of seven segments and a long narrow tail-like posterior postabdomen or metasoma of five segments terminating in a vesicle bearing a poison sting. The members have three groups of eyes on the anterior part of the cephalothorax, one median of two eyes and a lateral group at each anterior margin of two or three eyes each; small chelate cheliceræ; large conspicuous pincer-like pedipalpi; a pair of peculiar comb-like organs, pectines, on the venter of the second abdominal segment; four pairs of book-lungs opening on the lower side of the third, fourth, fifth, and sixth abdominal segments.

The scorpions vary from two to six inches in length and frequent the warmer regions. They are nocturnal, hiding by day under stones, logs, and in cracks and holes in the ground; creeping forth at night to prey upon ground-inhabiting insects and other small animals which are held by the large pincers while the sting is used to paralyze or to kill the prey which is subsequently crushed into bits by the coxæ of the pedipalps and eaten. *The sting, while often quite painful, is rarely ever fatal to man.* All are viviparous, the newly hatched young being carried on the backs of the females until after the first molt when they are able to shift for themselves.

Common Western Species

There is yet much to be done towards a better understanding of the species, habits, and distribution of our Western forms. Wood [1] describes a number of new species, Underwood [2] lists the North American species, Banks [3] lists most of the California species, and finally Comstock [4] describes those common to our territory.

The spotted scorpion, *Isometrus maculatus* (Linn.), is a dull yellow form mottled with black; from two to three inches long; cauda and palpi very long and slender. California and neighboring states are its habitat.

The slender clawed scorpion, *Tityus tenuimanus* Banks, is pale yellow, two inches long with slender fingers one and one-half times the length of the hand. It is found in Central California.

The slender tail scorpion, *Centrurus exilicauda* Wood, is a slender species, with long slender cauda, found in Southern and Lower California and Western Mexico. It is much feared by the natives of Mexico.

The California scorpion, *Centrurus californicus* (Girard), is a strongly granulated species, dark brown, two inches long, often with two dark body stripes and a distinct tooth on the vesicle below the sting. It inhabits Lake County, California.

Allen's scorpion, *Broteas alleni* (Wood), is a small polished species from one to one and one-half inches long. It is found in Southern and Lower California.

[1] H. C. Wood, Jr., *Jour. Phil. Acad. Nat. Sci.* New Ser. Vol. 5, 1874, p. 359.

[2] L. M. Underwood, *Can. Ent.*, Vol. 17, 1885, p. 164.

[3] N. Banks, "The Scorpions of California." *P. C. Jr. Ent.* 2, No. 2, 1910, p. 185. N. Banks, *Am. Natur.*, Boston, Mass., 34, 1900, p. 423.

[4] J. H. Comstock, *The Spider Book.* Doubleday, Page & Co., N. Y. 1912.

The Mordant scorpion, *Uroctonus mordax* Thorell, is a very dark form two and one-half inches long with large pincers. It is common along the northern California coast and extends into Oregon.

The shining sting scorpion, *Anuroctonus phaiodactylus* (Wood), is a large reddish-brown species somewhat hairy. The hand is very much swollen and the sting of the male, enlarged and shining. This is a desert and arid form occurring in California, Nevada, and Utah.

FIG. 6.—The Northern scorpion, *Vejovis boreus* (Girard).

Vejovis punctipalpi Wood is reddish-brown with long slender sting. It is nearly two and one-half inches long and is a desert species of Arizona, Southern and Lower California.

The Northern scorpion, *Vejovis boreus* (Girard) (Fig. 6), is a rather small yellow or greenish scorpion distributed throughout the Northwest, being known in California, Oregon, Washington, Idaho, Montana, Utah, and Nevada.

The smooth tail scorpion, *Vejovis spinigerus* (Wood), is a species two inches long, distinguished by a smooth tail marked with black lines. It occurs in California, Arizona, New Mexico, and Texas.

The hairy tail scorpion, *Vejovis hirsuticauda* Banks, is a small reddish-brown species one and one-fourth inches long with the stinging vesicle densely hairy beneath like a brush. It is found in Southern California.

PEDIPALPIDA (Order)

Whip Scorpions

The Pedipalpida comprise arachnids with unsegmented cephalothorax and flattened abdomen of eleven or twelve segments; cheliceræ simple, two-jointed; powerful pedipalpi which are simple or chelate; four pairs of legs, the first pair used only as tactile organs and have the tarsus modified into a many-jointed flagellum; the organs of respiration consist of two pairs of book-lungs on the venter of the second and third abdominal segments.

The whip scorpions are of ancient origin and have a world distribution. But little is known concerning their habits, except that they are nocturnal and are found under stones, bark of trees, and in holes and caves in the ground.

A single species, *Trithyreus pentapeltis* (Cook), occurs in the semi-arid and desert regions of Southern California. It is a small species from 4.5 mm. to 7.5 mm. long, the males being of a dark reddish-brown and the females of a bright yellowish hue. They are found under dry leaves.[1] On April 5, 1925, the author took three specimens and F. H. Wymore one specimen in Palm Canyon, Southern California. They occurred under rocks among damp leaves and litter not far from the stream. All forms were pale pinkish or reddish.

[1] Margaret Moles, "Another Record of a Small Whip Scorpion in California." *P. C. Jour. Ent. & Zoöl.*, 9, 1917, p. 1.

PSEUDOSCORPIONIDA (Order)[1]

False Scorpions

The false scorpions are tracheate arachnids with four stigmata; unsegmented cephalothorax; abdomen twelve-segmented united to the cephalothorax by the whole width, and without the postabdomen or sting of the scorpions; cheliceræ chelate bearing openings of the spinning organs; pedipalpi large, six-jointed, chelate.

These minute animals are indeed very interesting in form and habit. The spinning glands enable them to make very compact little webs or sacs (Fig. 7) within which eggs are laid or molting takes place. They are carnivorous and may often be taken in considerable numbers on or under the bark of trees, under stones, and in old buildings. Occasionally they are found clinging to the legs of flies, stealing a ride, probably as a means of dispersion.

There are a large number of western species described but only one as a representative form is included here (Fig. 7).

Apocheiridium ferumoides Chamberlin[2] is 1.5–2 mm. long, pale tan, reddish or brownish; molting and egg webs are white silken disc-like, 2 mm. in diameter; eggs white, irregular, somewhat globular, laid in groups of four within webs; immature forms pale. This very interesting species is common under the loose bark of eucalyptus, cypress, pine, redwood, and similar trees in the San Francisco Bay region, California, where the disc-like webs are often abundant.

PHALANGIDA (Order)[3]

Harvesters, Harvestmen, Harvest Spiders.

The Phalangida are tracheate arachnids with unsegmented cephalothorax broadly united to the short segmented abdomen; cheliceræ chelate and three-jointed; pedipalpi leg-like; one pair of simple eyes; pair of odiferous glands on cephalothorax; no spinning organs.

These long-legged creatures with small bodies are variously known as harvesters, harvestmen, harvest spiders, shepherd spiders, grand-daddy-long-legs, grandfather-gray beards, and so forth. They are familiar to all the rural population. Their habits are not well known and much superstition and folk-lore exists concerning them. They are largely

[1] Nathan Banks, *Pseudoscorpionida. Jour. N. Y. Ent. Soc.*, 3, 1895, p. 1. *Pseudoscorpionida* of California. *P. C. Jour. Ent.*, 3, 1911, p. 633. A New Pseudoscorpion from California, *P. C. Jour. Ent. & Zoöl.*, 6, 1914, p. 203.

R. K. Coolidge, List of N. A. *Pseudoscorpionida. Psyche*, 15, 1908, p. 108.

J. H. Comstock, *The Spider Book.* Doubleday, Page & Co., N. Y., 1912, p. 39.

Margaret Moles, "Pseudoscorpions in the Claremont-Laguna Region." *P. C. Jour. Ent. & Zoöl.*, 6, 1914, p. 187.

Winifred Moore, "Two Pseudoscorpions from Claremont-Laguna Region." *P. C. Jour. Ent. & Zoöl.*, 9, 1917, p. 26.

J. C. Chamberlin, "Notes on Genus *Garypus* in N. A." *Can. Ent.*, 53, p. 186, 1921.

[2] J. C. Chamberlin, *Pan Pacific Ent.* 1, pp. 35–36, 1924.

[3] Nathan Banks, "The *Phalanginæ*." *Can. Ent.*, 25, 1893, p. 205. "The *Phalangida Mecostethi* of the United States." *Trans. Am. Ent. Soc.* 20, 1893, p. 149.

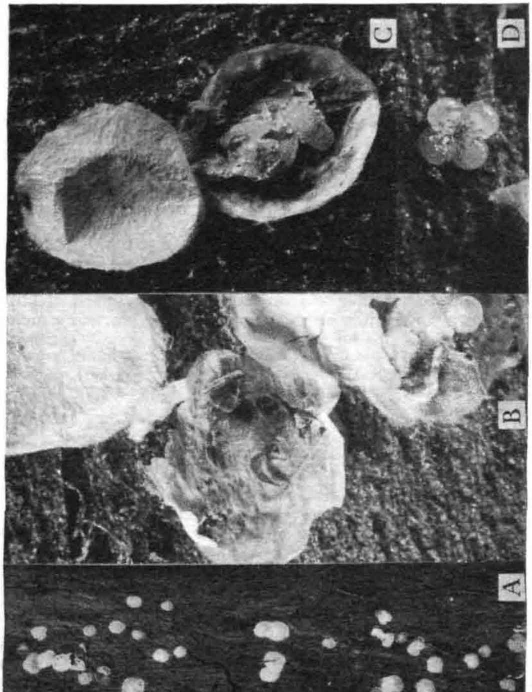

FIG. 7.—The false scorpion, *Apocheiridium ferumoides* Chamberlin. A, molting and egg webs on the underside of bark of eucalyptus tree; B, web opened to show molting within, egg web opened below; C, young hatching from eggs in web; D, group of eggs removed from a web.

nocturnal, but often appear in large numbers on dull or cloudy days. The food is chiefly vegetarian consisting mostly of dead material, but they are at times injurious to tender plants.

There are such a large number of genera and species that no attempt at listing them will be made. Rather the student is referred to the works of Banks, Comstock,[1] and others.[2]

SOLPUGIDA (Order) [3]

Solpugids, Sun Spiders, Vinegarones, etc.

This order comprises tracheate arachnids having the cephalothorax divided into six segments, the first three coalesced to resemble a head; and a segmented abdomen constricted at the base, giving the appearance of three rather distinct body regions. The cheliceræ are chelate and the pedipalpi are well developed and leg-like with terminal sense organs. The first pair of legs are tactile while only the last three pairs are ambulatory.

These very interesting arachnids (Fig. 8), are densely covered with hairs, have no spinning organs, are very swift and agile, and nocturnal in habits, living in warm, dry desert regions. They are common in many parts of the world and are known by numerous common names. In the western parts of America they are called "solpugids," "sun spiders," and "vinegarones." To the Arabs they are known as "akreb-errih" (wind scorpions), to the Spanish as "aranas del sol" (spiders of the sun) and "mata venado" (kill deer), to the Russians as "flangas," to the Dutch of South Africa as "Jagt spinnekop" (hunting spiders), and to the Mexicans as "Gluvia" or "Genisaro." They are very much feared in many lands, but are perfectly harmless.

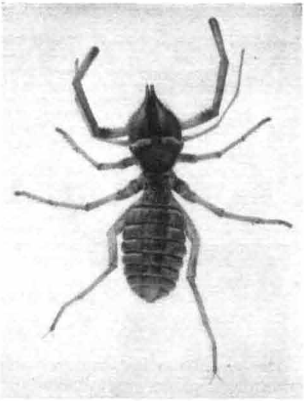

FIG. 8.—The common solpugid, *Eremobates pallipes* (Say). (Photo furnished by W. B. Herms.)

Solpugids feed chiefly upon living arachnids, insects, and other small

[1] J. H. Comstock, *The Spider Book*, Doubleday, Page & Co., N. Y., 1912, p. 53.

[2] Clarence M. Weed, "Desc. of New or Little Known N. A. Harvest Spiders." *Trans. Am. Ent. Soc.*, 19, 1892, p. 187.

[3] J. Duncan Putnam, "The *Solpugidæ* of America." *Proc. Davenport Acad. Nat. Sci.*, 3, 1883, p. 249.
Nathan Banks, "*Solpugida*." *Amer. Naturalist*, 24, 1900, p. 426.
J. H. Comstock, *The Spider Book*. Doubleday, Page & Co., N. Y., 1912, p. 36.

animals which are taken on the run. The young and adults usually appear at night in roads, paths, streets, and buildings and may be taken during the day under stones, boards, logs, "buffalo chips," and so forth, resting in small holes in the ground, where the eggs are deposited by the females.

In our region they are most abundant in the arid Southwest and range as far north as middle California, Nevada, Utah, and Colorado.

The common genera and species are as follows:

KEY TO GENERA [1]

1. Anterior margin of cephalothorax truncate 2
   Anterior margin of cephalothorax subconical .... **Ammotrecha**
2. Hind tarsus consisting of a single segment .... **Eremobates**
   Hind tarsus three-jointed .... **Hemerotrecha**

WESTERN SPECIES

Eremobates californica (Simon). Length 25 mm., bright fawn color. Southern California, Arizona, Northern Mexico.
cinerea (Putnam). 26 to 27 mm., pale reddish brown. Arizona.
formicarius (Koch). Southern California, Arizona, New Mexico, Mexico.
formidabilis (Simon). Large fulvous species with broad, dark, dorsal longitudinal band on abdomen. California and Arizona.
magna Hancock. Tips of the palpi are black. California, Arizona, and Texas. Howard reports this species destroying great numbers of ants in Texas.[2]
pallipes (Say) (Fig. 8). Our most common species, 24 mm., pale fawn with indefinite dorsal band. California, Colorado, Utah, Wyoming, Nevada, Arizona, New Mexico, and Kansas.
putnami Banks. California.
Hemerotrecha californica Banks. Coastal region of California.
Ammotrecha californica (Banks). Southern California.
peninsulana Banks. Arizona.

ARANEIDA (Order)

Spiders

The spiders comprise the largest order of the Arachnida and are common everywhere. They are distinguished by having the two body regions, the cephalothorax and the abdomen unsegmented; partially chelate cheliceræ with poison fangs; simple leg-like palpi; and a respiration system consisting of lung-books or lung-books and tracheæ situated on the ventral base of the abdomen. The silk used in spinning their extensive webs originates from two or three pairs of spinnerets situated ventrally at the tip of the abdomen.

Spiders are predaceous on small living animals including, for the most part, insects which are ensnared in the webs. Their bites usually quickly kill their prey and ordinarily do not affect man. A few species, however, are exceedingly venomous and a bite from one of them may result in great pain and even death.

A few of the interesting common species are all that can be included.

[1] J. H. Comstock, *loc. cit.*
[2] L. O. Howard, *Ent. News*, 28, July, 1917, p. 310.

The most common poisonous species in the West is a medium-sized black spider with a red mark the shape of an hour glass on the venter of the female abdomen. It is known as the **black widow or hour glass spider,** *Latrodectus mactans* Fabr., and occurs under boards, logs, stones, masses of weeds, debris, and occasionally in houses and barns.

The common orange garden spider, *Miranda aurantia* (Lucas), with its large orb webs and pear-shaped egg masses, is a common sight in late fall everywhere in this region and throughout the United States, Mexico, and Central America.

The silver orb spinner, *Argiope argentata* (Fabr.), is a beautiful large silvery spider common on sage brush and cactus in the foothills of Southern California.

The common trap-door spider of Southern California, Arizona, and adjoining territory, is *Bothriocyrtum californicum* Cambridge (Fig. 9). The large burrows in the ground are lined with silk and the entrance is

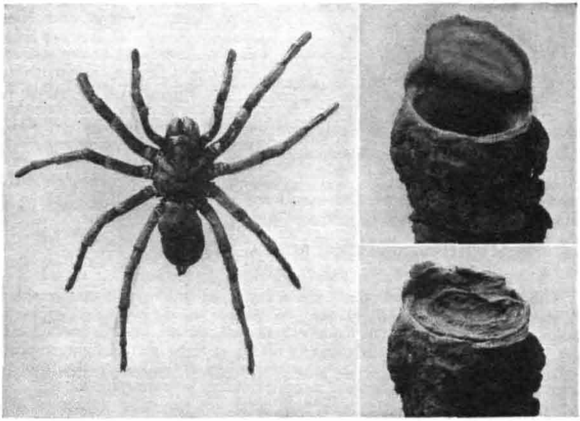

Fig. 9.—Common trap-door spider, *Bothriocyrtum californicum* Cambridge, showing entrance to burrow with trap-door open and closed.

closed by the most exquisite little trap-door which is held tight by the watchful inmate if disturbed and is sealed down during the hibernating period in autumn and winter. With all these precautions, however, the spider is parasitized by a wasp, *Psammochares planatus* (Fox), and succumbs in the nest, after which the adult wasp cuts out through the sealed door.[1]

[1] A. Davidson, *Entom. News*, 16, 1905, p. 233.

The trap-door spider of Central California, *Eutychides versicolor* Simon, constructs a long narrow burrow usually branched, with a thin door, in the dry fields and on the hillsides. *Brachythele longitarsis* Simon is a common species in California and Arizona.

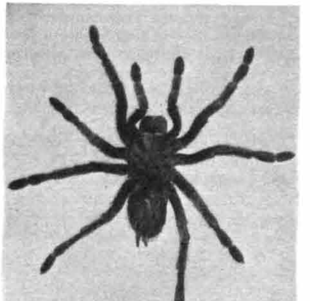

FIG. 10.—The California tarantula, *Eurypelma californica* Ausserer.

There are a number of large hairy tarantulas, exciting much fear and interest, which might be mentioned.

The California tarantula, *Eurypelma californica* Ausserer (*E. steindachneri* Auss.) (Fig. 10), occurs in Arizona, California, New Mexico, Texas, and other States, inhabiting the dry southern slopes of the hills; *E. helluo* Simon occurs in Arizona; *E. leiogaster* Ausserer is Californian; *E. marxi* Simon inhabits Colorado and New Mexico; *E. rusticum* Simon, Arizona and New Mexico. Nearly all of these large hairy dark or light brown spiders burrow into the ground or utilize small holes from 1 to 2 inches in diameter near rocks, roots, or other objects. The tunnels are lined with silk and the entrance webbed to form a neat rim or to conceal it entirely. These spiders are ferocious in appearance, and while considered very dangerous, are unable to inflect more than temporary pain and injury.[1]

ACARIDA (ACARINA, ACARI, ACARIDEA) (Order)

Ticks and Mites

This order consists of small and minute arachnids with unsegmented bodies; usually 2-jointed, chelate, or simple cheliceræ; variable pedipalpi which may be simple, leg-like, raptorial, tactile, or abortive according to habits; mouth parts adapted for biting, piercing, and sucking; respiratory system tracheal or by the general surface of the body; from two to four pairs of legs, normally four pairs; primitive metamorphosis.

Of all the arachnids the ticks and mites are the most numerous and troublesome to mankind, birds, and domestic animals, while there are also a large number of serious plant pests among the mites.

The Order *Acarida* is separated into a number of superfamilies, one of which includes the ticks while a number embraces the mites. The ticks are separated from the mites in a general way as follows:

Hypostome or tongue large and armed with sharp teeth; exoskeleton leathery; bodies quite large . . . . Ticks

Hypostome or tongue small and hidden in the body, not armed; exoskeleton not leathery; bodies minute . . . . Mites

[1] W. J. Berg, "Regarding the Habits of Tarantulas and the Effects of their Poison," *Scientific Mthly.* 4, No. 5, 1922, p. 482.

IXODOIDEA (Superfamily)[1]

Ticks

The ticks are the largest members of the *Acarida* and are ectoparasitic, attaching themselves to mammals, birds, and reptiles, and inhabit the warmer regions of the world. Besides causing annoyance and pain many of them transmit dangerous and deadly diseases to man and domestic animals. This is particularly true in the tropics, but some diseases are transmitted by ticks in the northern parts of the Western States.

There are two families of ticks separated as follows:

Shield or scutum absent...**Argasidæ**
Shield or scutum present..**Ixodidæ**

ARGASIDÆ[2] Argasine Ticks.

Of these the most common is **the cosmopolitan fowl or chicken tick, adobe tick, blue bug, Persian Miana bug, or the tampan,** *Argas persicus* (Oken) (*A. miniatus* Koch, *A. americanus* Packard, *A. sanchezi* Dugès[3] (Fig. 11), which is a very serious pest to poultry, particularly chickens, such wild birds as quail, doves, and pigeons, but rarely attacks domestic animals and man. In this country it is a southern tick, inhabiting Florida, Texas, New Mexico, Arizona, and much of California. The adults are oval, thin and flat with a rough granular surface, varying in color from reddish to purplish-brown, and in length from 8 to 10 mm. and half as much in width. The small spherical reddish-brown eggs are laid in masses in cracks and other hidden places. The larvæ are reddish and hexapod until after the first molt when another pair of legs appears. The young ticks fasten themselves to the hosts and feed for several days before dropping off, while half-grown forms and the adults hide during the day and sally forth at night to feed upon the fowls. They cause serious injury and unless controlled render the flock useless for egg production and may even kill the birds. Cleaning out and thoroughly spraying the chicken houses and yards with carbolineum and distillate or with a strong miscible oil spray give satisfactory control if done two or three times a year. There is a complete and up-to-date treatise on this tick by F. C.

[1] D. E. Salmon and C. W. Stiles, *The Cattle Ticks of the U. S.*, U. S. D. A., Bur. Anim. Ind., 17th Ann. Rept. 1901, p. 380.
Nathan Banks, *Ixodoidea of the U. S.*, U. S. D. A., Bur. Ent. Tech. Ser. 15, 1908.
W. A. Hooker, "Life History, Habits and Methods of Study of *Ixodoidea*.", *Jour. Econ. Ent.* 1, 1908, p. 34. "Some Host Relations of Ticks. *Jour. Econ. Ent.* 2, 1909, p. 251. "Geographical Distribution of American Ticks." *Jour. Econ. Ent.* 2, 1909, p. 403.
W. B. Herms, *Medical and Veterinary Entomology*, Macmillian Co., N. Y., 1915, p. 296.
W. A. Riley and O. A. Johannsen, *Handbook of Medical Parasitology*. Comstock Pub. Co., Ithaca, N. Y., 1915, p. 62.
W. Dwight Pierce, *Sanitary Entomology*. Richard G. Badger, Boston, Mass., 1921. p. 403.

[2] Geo. H. F. Nuttall, Cecil Warburton, W. F. Cooper, and L. E. Robinson, *Argasidæ*. Cambridge Univ. Press, London, part 1, 1908, Oct.

[3] Bul. No. 106, Bur. Ent. U. S. Dept. Agr., 1912, p. 46.
F. C. Bishopp, Circ. No. 170, Bur. Ent. U. S. Dept. Agr., Mar. 31, 1913.

FIG. 11.—The chicken tick, *Argas persicus* (Oken). Top shows characteristic colony of young ticks attached to the underside of the wing of a chicken; bottom shows adult ticks. (Adults after Herms.)

Bishopp in U. S. Dept. Agr., *Farmers' Bulletin* 1070, 1919, for those wishing more information.

The ear tick or the spinose ear tick, *Otobius megnini* (Dugès)[1] (*Ornithodoros megnini* Dugès), occurs throughout the Western States, having been reported in practically all of them. The adult has a broadly rounded body conspicuously constricted in the middle; the color varies from reddish-brown to black, the surface being minutely roughened with stiff, short, bristle-like spines; all stages are eyeless; the swollen females average from 7 to 8 mm. in length. The ticks feed deep in the ears of horses, cattle, sheep, and have been taken from the ears of humans. In all cases severe pain is produced by their bites. Imes[2] secured good control by mixing 2 parts (by volume) of commercial pine tar with 1 part of cottonseed oil, which was then warmed to flow and applied in $^1/_2$ ounce doses with a syringe. Several treatments thirty days apart were necessary.

The pajaroello or talajas, *Ornithodoros coriaceus* Koch (Fig. 12), is a large, rough and granular, brownish or dirty colored tick measuring from 10 to 12 mm. in length, rounded at the posterior end and with projections anteriorly, sides parallel with only a slight median constriction, and with four eyes. It has been reported from South America, Mexico, and California. In California it has been taken most often in the region of Mt. Hamilton, in the central part of the State, where it is abundant in deer beds, but it has also been reported as occurring at Los Olivos in Santa Barbara County by Nuttall.[3] It is a venomous tick which attacks deer, cattle, and humans.

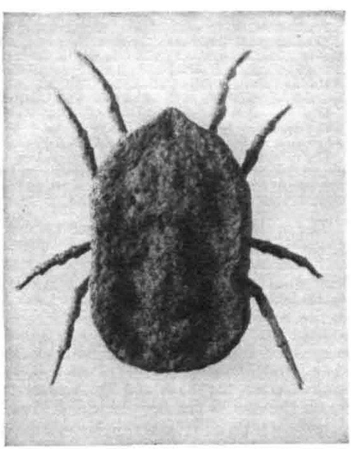

FIG. 12.—The pajaroello or talajas, *Ornithodoros coriaceus* Koch.

The adobe tick, turicata, or pajaronela, *Ornithodoros turicata* (Dugès) (*O. americanus* Marx), has the sides of the body almost parallel, a granular surface and no eyes. The color is light brown, with the legs paler. The length of the swollen female averages from 6 to 7 mm. This tick occurs in Arizona, California, New Mexico, Florida, Mexico, and South America and severely attacks hogs, cattle, and humans. It should, not be confused with the chicken or fowl tick, which is also known as the adobe tick, for both inhabit the Mexican and Indian adobe houses and under such conditions both attack the occupants.

[1] *Farmers' Bul.* 1150, U. S. Dept. Agr., Dec., 1920, p. 13.
European authors use *Ornithodorus*, while the Americans retain *Ornithodoros*.
[2] M. Imes, *Farmers' Bul.* 980, U. S. Dept. Agr., May, 1918.
[3] Geo. H. F. Nuttall, Cecil Warburton *et al.*, *loc. cit.*, p. 57.
S. B. Freeborn also reports it from El Tejon and Bakersfield, Cal. and W. B. Herms records it as ranging south into Mexico.

The talaje tick, *Ornithodoros talaje* (Guérin-Meneville), is yellowish or brownish-red pointed anteriorly and rounded posteriorly with almost parallel sides, granular surface, no eyes, and is from 5 to 6 mm. long and 3 to 3.5 mm. wide. It occurs in South America, Central America, Mexico, Hawaii, Florida, Texas, Nevada, and on San Clemente Island, California. The hosts are horses and humans.

IXODIDÆ [1] The Ixodine or Shield Ticks.

The castor bean tick, *Ixodes ricinus* (Linn.), gets it common name from the color, size, and shape of a castor bean. It is regularly oval, pale and reddish-brown throughout, covered with short white hairs and may attain 11 mm. in length. It is a cosmopolitan species and has been taken from dog, cat, cattle, sheep, deer, wild cat, panther, rat, horse, goat, mole, skunk, fox, hare, mouse, ground squirrel, and various other animals and man. In the West it has been recorded from California and British Columbia. It also occurs elsewhere in the United States.

The variety tick, *Ixodes ricinus californicus* Banks, is narrower, and has been taken from the California Coast Region on gray fox, black-tail deer, and cattle.

Pratt's tick, *Ixodes pratti* Banks, infests gophers in Death Valley, California.

The hexagonal tick, *Ixodes hexagonus* Leach, is, as the common name implies, hexagonal in shape and measures 8 mm. in length and 5 mm. in width. It occurs on squirrels in California and on sheep and rabbits elsewhere in the United States.

The narrow tick, *Ixodes angustus* Neumann, is an elongate species infesting ground squirrels, rabbits, wood-rat, chipmunk, and similar animals, and occurs from Alaska to California, and in Idaho.

The equal tick, *Ixodes æqualis* Banks, is closely akin to the preceding species and has been taken from ground squirrels at Berkeley, California.

The rotund tick, *Ixodes kingi* Bishopp,[2] is pale gray and almost globular when engorged, hence the common name. It infests the badger, gopher, marmot, skunk, dog, pine squirrel, chipmunk, and ground squirrel, and occurs throughout the entire Western Region, west of the Rocky Mountains.

The cattle tick, North American fever tick, or the Texas cattle fever tick, *Margaropus annulatus* Say [*Boöphilus bovis* (Riley)], is the most important and dangerous cattle tick from the fact that it is the carrier of *Babesia bigemina* Smith and Kilbourne, a protozoan parasite which causes Texas cattle fever, which in the past years has been fatal to thousands of cattle in this country. The female ticks are regularly oval with a slight median constriction, chestnut brown in color and from 10 to 12 mm. long when engorged. It is typically a cattle tick, but has been taken from deer, sheep, and horses. The distribution includes the Southern Gulf States from Virginia to Texas and the Southern part of California. In California the species has been practically eradicated for a number of years. A Federal quarantine prevents the spread into new territory.

The rabbit tick, *Hæmaphysalis leporis-palustris* (Packard), is broadly oval posteriorly and narrower anteriorly, longer than broad, coarsely punctate, and the female 11.3 by 7.5 mm. when replete. This tick occurs in South America, Central America, Canada, and the United States. It is found in all of the Western States. The hosts are rabbits and birds. The ticks attach themselves to the insides and outsides of the ears of rabbits and may so seriously weaken them that they fall an easy prey to natural enemies. Birds are infested on the neck and around the eyes and ears and on the crest of the head. Quail and meadow larks are reported to be killed by them.[3] The author has also taken them on cats.

[1] Geo. H. F. Nuttall, Cecil Warburton, W. F. Cooper, and L. E. Robinson, *Ixodidæ*. Cambridge Univ. Press, London, part 2, 1911, May; part 3, 1915, Oct.

[2] U. S. D. A. Bur. Ent. Bul. No. 106, 1912, p. 82.

[3] U. S. D. A. Bur. Ent. Bul. No. 106, 1912, p. 106.

The American dog or wood tick, *Dermacentor electus* Koch (*D. variabilis* Say), is the commonest tick in the Eastern part of the United States, but also occurs along the Pacific Coast in California and Oregon with the Rocky Mountain Region apparently free. The adults are reddish-brown with irregular whitish marks on the dorsum. Engorged females measure from 10 x 7 mm. to 15 x 11 mm. The dog is the common host of the adult stage although they also infest cattle, horses, deer, rabbits, squirrel, racoon, opossum, coyote, badger, skunk, and sometimes humans.

The western dog tick or net tick, *Dermacentor occidentalis* Neumann, is the most abundant tick in the Pacific Coast Region and is therefore also known as the Pacific Coast Tick. The adults resemble those of the preceding species being reddish-brown with white markings or almost entirely white. The tick infests dogs, cattle, sheep, horses, deer, ground squirrels, and is often a serious pest to man. It is the tick commonly acquired in the brushy areas of Central and Western California and Western Oregon. The deer is, however, the preferred host.

The Rocky Mountain spotted fever or wood tick, *Dermacentor venustus* Banks (*D. andersoni* Stiles),[1] is a pest because it transmits the causative agent of Rocky Mountain Fever, a serious disease which affects man. The organism producing the fever is supposed to be *Dermacentroxenus rickettsi* Wolbach. The tick is reddish-brown with whitish markings and occurs throughout the Western States from the Rocky Mountains to the Pacific Ocean. It is, however, most abundant in the Northwest and especially in Montana and Idaho. The hosts of the adults include, man, cattle, sheep, dogs, rabbits, deer, and other domesticated and wild animals. The young commonly infest ground squirrels and other small rodents.

The winter tick, moose tick or elk tick, *Dermacentor albipictus* (Packard),[2] is elongate with a long shield, and reddish-brown body streaked with white. Engorged females appear olive green above and slate-colored beneath and vary from 9 to 14 mm. in length. It occurs throughout the Western States west of the Rocky Mountains, including British Columbia, as well as in some of the New England States. The tick feeds in all stages upon the hosts which include moose, elk, beaver, deer, mountain goat, horse, and ox.

The jack rabbit tick, *Dermacentor parumapertus* Neumann, is a dark reddish-brown immaculate species commonly taken on jack rabbits, but also has been reported on man and in a chicken house in California by Banks.[3] It also occurs in Arizona.

The margined tick, *Dermacentor parumapertus marginatus* Banks, is much like the preceding but the scutum of the female is margined with white. The adults attach themselves to the ears of jack rabbits and dogs, while the hosts of the young are unknown. The distribution is limited to the Southwest including Western Texas, New Mexico, Arizona, Nevada, California, Southern parts of Oregon, Utah, and Mexico. A hymenopterous parasite, *Hunterellus hookeri* Howard, has been reared from partly engorged nymphs taken from dog and jack rabbit in California by H. P. Wood.[4]

[1] W. D. Hunter and F. C. Bishopp. Bul. 105, Bur. Ent. U. S. Dept. Agr. 1911. In a recent paper entitled "A Fifty-year Sketch History of Medical Entomology," *Rept. Smiths. Inst.* for 1921, p. 578, 1923, Dr. L. O. Howard reverses the synonomy as herein given.

[2] F. C. Bishopp and H. P. Wood, *Parasitology*, 6, No. 2, July 16, 1913, p. 161.

[3] Bull. 106, Bur. Ent. U. S. Dept. Agr. 1912, p. 159.

[4] *Jour. Econ. Ent.*, 4, 1911, p. 425.

ACARINA (Group) [1]

Mites

Mites are of great interest not only because of their minuteness, their varied forms and adaptations for living under widely different conditions, but also because of their complex interrelationships and their influence on the welfare of man by direct attacks and by infesting domesticated animals and plants. It is not the purpose of the writer to review mites in general, but rather to discuss those which may be considered of economic importance in our region.

EUPOPIDÆ. Eupopid Mites.

A family of small delicate mites with soft bodies and long 6 or 7 jointed legs terminating in two simple claws and sometimes with plumose pulvilli. There is a pair of suckers each side of the genital opening for clasping to smooth surfaces. They are very active and are normally predaceous on other mites and on small insects.

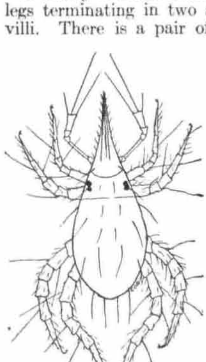

FIG. 13.—The red snout mite, *Bdella utilis* Banks.

The green wheat mite, *Notophallus viridis* Banks, is dark greenish with reddish legs and a red spot on the posterior portion of the dorsum and another below on the venter. This mite is further characterized by having the anal opening on the dorsum of the abdomen. Unlike most of the members of the family, it is a plant feeder and seriously attacks wheat plants, being particularly destructive to the young plants. It occurs in Arizona.

BDELLIDÆ. Snout Mites.

The members of this family are commonly called snout mites because of the well-developed and prolonged rostrum. They are rather slender with long slender legs and palpi which are often elbowed; very agile, moving forward and backward quickly; and mostly reddish in color. The eggs are covered with spines. They inhabit the colder regions and temperate zones and are predaceous in habits. There are many species two of which are recorded from the west.

Bdella utilis Banks (Fig. 13) is a bright-red mite abundant on the leaves of citrus trees in Southern California and predaceous on black and other scale insects and on injurious orchard mites.

[1] *Acarina* also includes the ticks.

Herbert Osborn and L. M. Underwood, "List of *Acarina* of N. A." *Can. Ent.*, 18, 1886, p. 4.

Nathan Banks, "A Treatise on *Acarina* or Mites. *Proc. U. S. Nat. Mus.* 28, 1904, p. 1.

N. Banks, "Some New N. A. *Acarina*." *Trans. Am. Ent. Soc.*, 21, 1894, p. 209.

N. Banks, "Catalogue of the *Acarina*." *Proc. U. S. Nat. Mus.*, 32, 1907, p. 595.

Nathan Banks, *The Acarina or Mites*. Rept. No. 108, U. S. Dept. Agr. 1915.

H. E. Ewing, *Systematic and Biological Study of the Acarina of Ill.* Univ. of Ill. Bul. 7, No. 14, Dec. 5, 1909, p. 359.

Eupalus echinatus Banks is a small red species in Colorado attacking the adult Buffalo tree hopper, *Ceresa bubalus* Fabr.[1]

CHEYLETIDÆ. Cheyletid Mites.

These are very small, almost colorless oval mites characterized by a large distinct rostrum to which are attached enormous 3 to 5 jointed palpi, the rostrum being separated from the body by a deep constriction.

Cheyletus seminivorus Packard is an exceedingly small mite varying in color from pale yellow to pinkish, with palpi and beak darker than the body and legs. The length is about 0.50 mm. According to Ewing[2] this mite is predaceous on *Tyroglyphus* spp., and is often taken with them in cereals and cereal products. It was originally supposed to be a grain or seed feeder, hence the misleading specific name. It occurs throughout the country.

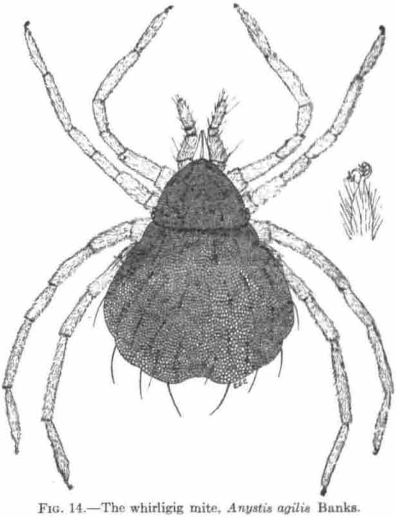

FIG. 14.—The whirligig mite, *Anystis agilis* Banks.

ANYSTIDÆ. Anystid Mites.

The mites differ from related forms by the closely set and radiating coxæ, slender prominent palpi, and rather long legs.

The whirligig mite, *Anystis agilis* Banks (Fig. 14), is bright red, oval, and nearly 1 mm. long. The young molt under a web in a crevice of the bark or on leaves. The adults are very agile and abundant on orange and lemon trees throughout the southern

[1] C. P. Gillette and C. F. Baker, *Catalogue Hemip. Colo.*, 1895, p. 66.
[2] H. E. Ewing, *Jour. Econ. Ent.*, 5, 1912, p. 416.

part of California, and are predaceous on aphis, young scale insects, small caterpillars, and small insects of all kinds. In Oregon it preys upon the larvæ of the bud moth, *Spilonota ocellana* (D. & S.).

TETRANYCHIDÆ.[1] Red Spiders.

Of the plant feeding mites these are the most injurious to agricultural crops and are responsible for great damage throughout this country and the world over. They are mostly very small, oval, variable in color from yellow, green, and red to brown; the abdomen and cephalothorax are separated by a shallow furrow; there are from 1 to 2 pairs of simple eyes; short 5-jointed palpi; moderately long legs terminating in simple or in from two to four-pieced claws; body provided with few, mostly long, simple hairs arranged in four longitudinal rows on the dorsum. The young are hexapod until after the first molt when another pair of legs is added. These mites are commonly known as red spiders because of the reddish color of some species and also as spinning mites from the extensive webs produced by many of them. The spinning organs are at the base of the mandibles. There are a large number of destructive species in our region.

Fig. 15. — The brown mite, *Bryobia prætiosa* Koch. (After Quayle.)

The brown mite, almond mite, or clover mite, *Bryobia prætiosa* Koch[2] (*B. pratensis* Garman) (Figs. 15, 16, c, d), is the largest of the mites infesting our plants. The adults average about 0.75 mm. in length, and the color is rusty brown, olive green, or reddish with the legs amber or orange. The species is at once distinguished by its large size; the long front legs which are as long as the body; the somewhat concave or flattened dorsum; the four anterior lobes; and the feather-like plates on the dorsum and margins of the body. The eggs are spherical, smooth, and rich cardinal red. The young are bright red in color. The eggs (Fig. 16, c, d), are laid singly or in compact masses throughout the summer, but the greatest numbers are deposited during the late summer and fall chiefly in the crotches or on the limbs and around the bases and on the fruit spurs of deciduous orchard trees and other host plants, where they are often so abundant as to cause the appearance of brick dust on the trees during the winter months. In the northern regions the mite winters only in the egg stage but in the States of Arizona, California, New Mexico, and the Southern States adults are commonly found in winter on various clovers, malva, and weeds. The eggs hatch in early spring in March, April, and May according to the climate, and the young mites often appear in great numbers on the opening blossom and leaf buds. During the summer

[1] H. J. Quayle, Bul., 234, Cal. Agr. Exp. Sta., Nov., 1912.
E. A. McGregor, *Proc. U. S. Nat. Mus.*, 56, 1921, p. 654.

[2] *Proc. U. S. Nat. Mus.*, 59, 1921, p. 661.

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the mites become very numerous, and besides doing great damage to fruit and ornamental trees, they may be found upon many other plants described below. There are from two to three broods a year.

The damage is caused by piercing the upper epidermis of the leaves and extracting the juices, causing first a yellowing and finally the dropping of the leaves. No webbing accompanies their attacks. They are most serious on almond trees, which are regularly infested year after year. Peach and prune trees are also attacked by great numbers of the mites, but are seldom seriously damaged. Alfalfa, clover, and peas are severely injured

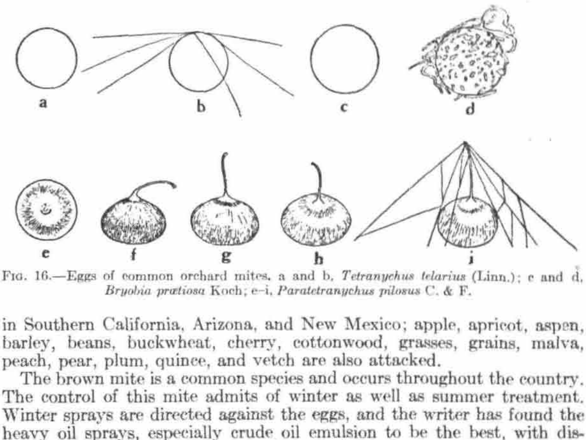

FIG. 16.—Eggs of common orchard mites. a and b, *Tetranychus telarius* (Linn.); c and d, *Bryobia prætiosa* Koch; e–i, *Paratetranychus pilosus* C. & F.

in Southern California, Arizona, and New Mexico; apple, apricot, aspen, barley, beans, buckwheat, cherry, cottonwood, grasses, grains, malva, peach, pear, plum, quince, and vetch are also attacked.

The brown mite is a common species and occurs throughout the country. The control of this mite admits of winter as well as summer treatment. Winter sprays are directed against the eggs, and the writer has found the heavy oil sprays, especially crude oil emulsion to be the best, with distillate emulsion and strong miscible oils less effective. Dormant lime-sulfur, 1–9, is next to crude oil emulsion in efficiency. The above sprays should be applied as delayed dormant sprays just before the buds begin to swell in the spring to give best results. Summer sprays as recommended for the common red spider, *Tetranychus telarius* (Linn), are also recommended for the clover mite. Repeated applications of water as a spray give very good results as a summer and fall control of this particular species.

The barley mite, *Tetranobia decepta* Banks,[1] is a small mite 0.65 mm. long, with slender legs, the first and last pair of which are longer than the body. It attacks barley and grasses in Arizona. The members of this genus have but a simple claw.

The jumping mite, *Tetranobia longipes* (Banks),[2] is a small yellow species 0.5 mm. long with the first pair of legs longer than the rest. Like the preceding mite it feeds on grain and grasses. It inhabits Arizona, California, and Utah.

[1] *Ent. News*, 28, 1917, p. 194. Orig. desc.
[2] *Proc. Ent. Soc. Wash.*, 14, 1912, p. 97. Orig. desc.

The California citrus mite, *Tenuipalpus californicus* Banks (Fig. 17), is broadly rounded in front and narrow posteriorly; legs short and crenulate; body crenulate, bright red, and 0.20 mm. long. The males are slenderer than the females. The eggs are bright red and elongate. This species occurs chiefly in the warmer citrus regions of Southern and Central California where it is often abundant on citrus trees, yet is seldom a pest.

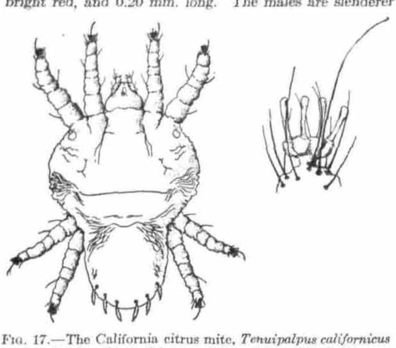

FIG. 17.—The California citrus mite, *Tenuipalpus californicus* Banks. End of foot at right. (After Quayle.)

The cardinal mite, *Tenuipalpus cardinalis* Banks, is as the name implies, a bright red species 0.35 mm. long. It has been reported on ash trees at Phœnix, Arizona.[1]

The crown mite, *Tenuipalpus coronatus* Can. and Fanz., is a European species infesting juniper trees in Colorado.

The cedar mite, *Tenuipalpus erythreus* Ewing, is a small robust, bright red mite, 0.35 mm. long and half as wide. Ewing[2] reports it from cedar in Iowa, and arborvitæ in Oregon.

The pale mite, *Tetranychoides californica* Banks[3] (Fig. 18), is a very small, pale white or yellowish species 0.24 mm. long, widest near the front with few body hairs and a large rostrum. The mites occur in small colonies in slight depressions which they cause on the undersides of the leaves and are most readily detected by the large number of

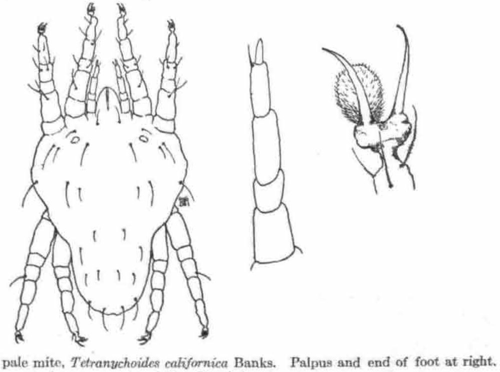

FIG. 18.—The pale mite, *Tetranychoides californica* Banks. Palpus and end of foot at right. (After Quayle.)

[1] N. Banks, *Proc. Ent. Soc. Wash.*, 14, 1912, p. 96. Orig. desc.
[2] Bul. Am. Mus. Nat. Hist., 37, 1917, p. 152.
[3] N. Banks. *Jour. N. Y. Ent. Soc.*, 12, 1904, p. 54. Orig. desc.

white cast skins. They spin a slight web under which they rest in a characteristic attitude with all legs extended. The species attacks citrus trees and occurs in various parts of the Southern and Central Coast Region of California. It is not known whether this is a native or imported species, but as yet it is not a pest.

The two-spotted mite, *Tetranychus* [1] *bimaculatus* Harvey, as the common and specific names imply, is a pale species with two large indefinite black spots occupying a great part of both sides of the body. The individuals vary in color from whitish to yellow, reddish, or pale green. It is a very common, web-spinning species and is often associated with the six-spotted mite and the common red spider. It occurs throughout much of the Western region and the entire country, and infests a great many plants including fruit trees, forest and native trees and shrubs, ornamentals, field and forage crops, and truck crops, embracing most of the same hosts as those listed under the common red spider, *Tetranychus telarius* (Linn.). For natural enemies and control measures also see *T. telarius* (Linn.).

The six-spotted or yellow mite, *Tetranychus 6-maculatus* Riley,[2] is a pale yellow species, immaculate or more often with three indefinite black spots on each side of the body. The eggs are round, translucent, or yellow. It occurs often in injurious numbers on the leaves of citrus trees in Southern California where it is often spoken of as the yellow mite. Control measures consist in the application of a 2 % or 3% commercial lime-sulfur solution or a combination of 1% of the above and 5 pounds of wettable sulfur to 100 gallons of water. The so-called soluble sulfur compounds of sodium or potassium sulphide give excellent control, but must be used sparingly because of the danger to the fruit and foliage of citrus trees.

The common red spider, *Tetranychus telarius* (Linn.),[3] is the most widely distributed and destructive red spider in the Western States. Its identity is somewhat confused, but usually may be considered to be the immaculate form varying in color from very pale yellow to orange, red, and greenish. The average length of the females is 0.42 mm. The eggs (Fig. 16, a, b), are globular and transparently pale-yellow; the young are whitish or yellowish. It is a profuse web spinner and infested plants and even the ground beneath may be completely covered with the webs. The mites hibernate mostly as adults in the soil in the cold regions, and in cracks and crevices of the bark of trees, in trash and on weeds and winter growing plants, in the warmer regions of our district. Adults appear usually in May or June and soon become evident by their destructive work.

[1] The writer is following Banks in the separation of the common species of *Tetranychus*. McGregor considers the following species as synonymous with *T. bimaculatus* Harvey: *T. desertorum* Banks, *T. gloveri* Banks, *T. opuntiæ* Banks, *T. verbesinæ* Ckll. *Proc. U. S. Nat. Mus.*, 56, 1920, p. 654.

The old genus *Tetranychus* is divided by Banks into three genera as follows:

Claw entire	*Paratetranychus*
Claw divided into two parts	*Schizotetranychus*
Claw divided into four parts	*Tetranychus*

[2] *Insect Life*, 2, 1890, p. 225. Orig. desc.

[3] Under this species Ewing has included as synonymous the following: *T. bimaculatus* Harvey, *T. 6-maculatus* Riley, *T. gloveri* Banks. Sta. Bul., 121, Ore. Agr. Exp. Sta., Aug., 1914.

Recent writers in Europe consider the American species under this name as being *Paratetranychus* (*Tetranychus*) *althaeæ* (v. Hanst) rather than the true *T. telarius* (Linn.).

Each female lays 50 to 60 eggs on the leaves, fruit or wherever the mites are feeding during a period of a week or ten days and the eggs ordinarily hatch in about three days. The young reach maturity in from ten to twelve days. The adults in summer live from one to two weeks while during the winter they continue to live for over four months. Their destructive work consists in the puncturing and draining of the epidermal cells of the host so that first there is a yellowing and finally a complete destruction of the tissues so as to drop the leaves, scar the fruit, or completely kill the plant. The seriousness of this work and of that by related mites is largely dependent upon climatic conditions and soil moisture. This explains the damage during the late summer and fall months particularly in hot regions where irrigation is not practical.

A fundamental consideration in the control is to keep the plants as vigorous as possible, conserve moisture by repeated cultivations or irrigations and by fertilizing. The mites usually disappear with the first fall rains in the West and this information has been utilized effectually in the application of water alone as a spray in many parts of California. However, for general control the following are recommended:

Dusts—Dry sulfur may be used alone or with a 10% filler of hydrated lime. The chief consideration in the use of sulfur is early and repeated applications, as little can be accomplished after the mites are present in great numbers. A power machine is necessary for successful orchard control. Usually 3 dustings are adequate.

Sprays—Winter control of this mite is of no avail because no winter eggs are laid and it does not hibernate in any great numbers on the trees. Summer sprays are very efficient if the work is thoroughly done, beginning early in the season as soon as the mites appear and continuing throughout the summer and fall if necessary. One or two complete sprayings usually suffice for a season. As a rule lime-sulfur solution is the basis of the spray. In fact many orchardists use nothing but a 2% or 3% solution of this liquid. Wettable sulfur sprays have also been used extensively in orchards and in gardens, and for field, forage, and truck crops are preferred because of less danger by burning. For general orchard purposes in the warmer sections a combination of commercial lime-sulfur and wettable sulfur is now preferred. The formula is 1 gallon of commercial lime-sulfur solution, 5 pounds of wettable sulfur, and 100 gallons of water. The soluble sulfur compounds usually sold as proprietary sprays have given satisfactory control during the past few years. They were used many years ago but discontinued because of injury to plants. If used properly, however, they are satisfactory on fruit trees such as prune, plum, pear, and so on, which have very hardy and tough foliage, but must be used very cautiously on trees and plants with tender leaves. The new highly refined lubricating oil emulsions are proving very effective in the summer control of red spiders and mites on deciduous and citrus fruit trees and on ornamentals and even truck crops, and are among the most promising sprays now in use for these pests.

The common red spider is an omniverous feeder attacking native as well as cultivated plants. A partial list of the host plants is given:

Abutilon, almond, apple, arborvitæ, ash, aster, barley, bean, blackberry, beet, birch, calla, cassava, castor bean, cat-tail, cherry, chrysan-

themum, citron, clematis, clover, corn, cotton, celery, cowpea, cucumber, currant, dahlia, eggplant, carnation, elm, hedge nettle, filaree, fuchsia, geranium, gooseberry, grape, grapefruit, heliotrope, hemp, hop, hop-tree, horse-chestnut, ironweed, Jimpsonweed, lemon, easter lily, evening primrose, maple, mignonette, monkey flower, morning glory, muskmelon, oats, okra, orange, passion vine, pea, peach, peanut, pear, pecan, pepper, phlox, pink, plum, poplar, prune, pumpkin, raspberry, rose, sage, smilax, sow thistle, squash, strawberry, sweet potato, sunflower, tea, tomato, verbena, vetch, walnut, watermelon, wheat, violet.

The boreal mite, *Tetranychus borealis* Ewing, is similar to *T. telarius* (Linn.) but is smaller and never orange or red in color. Ewing reports it on spirea in Oregon.[1]

The yellow mite, *Tetranychus flavus* Ewing,[2] is a small, pale green or yellow mite occurring chiefly above an altitude of 1000 ft. in the Pacific Northwest being a serious pest to the apple in some localities in Oregon. The hibernating forms are yellow and are found in the ground around the bases of the trees and on the trunks. The predaceous mite, *Sejus pomi* Parrott, feeds upon all stages of the yellow mite.

The mountain mite, *Tetranychus monticolus* McGregor,[3] is pale uniform amber in color. It seriously affects the leaves of the large-berried huckleberry, Mt. Hood, Oregon.

The Oregon mite, *Tetranychus oregonensis* Mc.Gregor,[4] is pale yellow or amber with or without pale lateral spots. It attacks wild cherry in Oregon.

The Pacific mite, *Tetranychus pacificus*, McGregor,[5] is yellow-amber with large lateral dark spots, superficially much like *T. bimaculatus* Harvey.

It has been taken on mock orange, vetch, and wild currant in Oregon, and on chinaberry in California.

Weldon's mite, *Tetranychus weldoni* Ewing,[6] greatly resembles both *T. bimaculatus* Harvey, and *T. telarius* (Linn.). It occurs in Colorado on apple, cottonwood, and prune.

The Willamette mite, *Tetranychus willamettei* McGregor,[7] is a pale lemon-yellow species causing a russeting of the leaves of valley oak in Oregon.

The corn mite, *Paratetranychus modestus* Banks,[8] is yellowish with large, dark irregular spots across the middle of the thorax. It causes a russeting of the corn leaves in Arizona, and in the Eastern States.

The European red mite, *Paratetranychus pilosus* C. & F.[9] (Fig. 19), is a deep cardinal red species with 4 dorsal rows of long curved spines which arise from tubercules on the back and which easily characterize the species. The adults feed usually on the dorsal sides of the leaves and on the tender stems and fruit, and move about freely. They spin lightly over the surfaces of the leaves and the masses of eggs, but never produce the dense webbing of the two-spotted mite and the red spider. The eggs (Fig. 16, e–i) are bright red, onion-shaped with minute corrugated surface and a central, dorsal, whitish stipe which is bent over at the tip. This stipe

[1] *Ann. Ent. Soc. Am.*, 6, 1913, p. 457. Orig. desc.

[2] *Ibid.*, p. 458. This mite must not be confused with *T. 6-maculatus* Riley which is also known as the yellow mite in Southern California.

[3] *Proc. U. S. Nat. Mus.*, 51, 1917, p. 584. Orig. desc.

[4] *Proc. U. S. Nat. Mus.*, 51, 1917, p. 585. Orig. desc.

[5] *Ibid.*, 56, 1920, p. 657. Orig. desc.

[6] *Ann. Ent. Soc. Am.*, 6, 1913, p. 457. Orig. desc.

[7] *Proc. U. S. Nat Mus.*, 51, 1917, p. 586. Orig. desc.

[8] Tech. Bul. No. 8, Div. Ent. U. S. Dept. Agr., 1900, p. 73. Orig. desc.

[9] For years this species has been known as the citrus red spider, *Tetranychus mytilaspidis* Riley.

E. A. McGregor, *Ann. Ent. Soc. Am.*, 9, No. 3, 1916, p. 284. P. Garman, *Jour. Econ. Ent.*, 14, 1921, p. 355. E. O. Essig, *Mthly. Bul.*, Cal. Dept. Agr. 11, No. 4, 1922, p. 409.

is about as long as the height of the egg and is often loosely webbed to indicate guy wires.

The life-history is somewhat similar to that of the clover mite in that the winter is passed in either the egg stage alone (in cold regions) or in both the egg and adult stages in the warmer regions. The overwintering eggs are laid in great masses on the large limbs or on the small twigs of deciduous plants and fruit trees, often being mistaken for those of the clover mite, and hatch in the spring. The summer eggs are laid whenever the mites are feeding on the leaves and fruit. In many parts of California and Arizona besides the winter eggs, the mites occur in considerable numbers during the winter on citrus trees, evergreen ornamentals, weeds, and cover crops, but breeding does not continue until the warm weather begins. The mites live from thirty to thirty-five days during summer and complete a life cycle in a month or six weeks, there being four or more generations a year. In the warm regions the species multiplies very rapidly, but it is also a serious pest in the cooler coastal regions as well.

In California this mite has been considered primarily a citrus-infesting species, but it is gradually becoming more and more a pest of deciduous fruit trees. Among the host plants are practically all kinds of citrus trees, almond, apple, peach, pear, plum, prune, other fruit trees, as well as ornamental and native shrubs and weeds.

The European red mite probably occurs generally throughout the country, because of the ease with which the minute winter eggs are carried on nursery stock. It has already been noticed in some of the Eastern States, and in the West it is recorded in Arizona, California, Idaho, Oregon, Utah, and Washington.

The natural enemies are practically the same as for the red spider, *Tetranychus telarius* (Linn.), as are also the summer control measures, while the winter sprays for the eggs are listed under the brown mite, *Bryobia prætiosa* Koch.

The date mite, *Paratetranychus simplex* (Banks),[1] is a pale yellow species 0.3 mm. long which seriously attacks and webs the fruit and leaves of the date palms in Southern California, but has also been taken from maple, cypress, and other ornamental trees at Sacramento, California.[2] This species, known as *Oligonychus simplex* (Banks), is reported as a serious pest of dates in Mesopotamia. *Paratetranychus heteronychus* Ewing is also a common pest of the date palm in Southern California according to F. Stickney. On the date palms both species are generally controlled by the use of miscible oil and crude carbolic emulsion, because lime-sulfur and wettable sulfur sprays spot the fruit by sticking tightly to it.

The green mite, *Paratetranychus viridis* (Banks),[3] is a greenish or yellowish species with a large blackish or reddish spot on each side of the cephalothoracic region; 0.4 mm. long. It is often associated with and works much like the date mite on the leaves and fruit of dates in the Imperial Valley of Southern California. It infests pecan leaves in Texas.

The alfalfa mite, *Schizotetranychus pratensis* (Banks),[4] is a pale green species which attacks alfalfa, clover, timothy, and other forage crops in Washington and neighboring States.

[1] *P. C. Jour. Ent. and Zoöl.*, 6, 1914, p. 57. Orig. desc.
[2] G. P. Weldon, *Mthly. Bul.*, Cal. Dept. Hort., 3, 1914, p. 338.
[3] *Trans. Am. Ent. Soc.*, 21, 1894, p. 218. Orig. desc.
[4] *Proc. Ent. Soc. Wash.*, 14, 1912, p. 97. Orig. desc.
E. A. McGregor, *Proc. U. S. Nat. Mus.*, 56, 1920, p. 668.

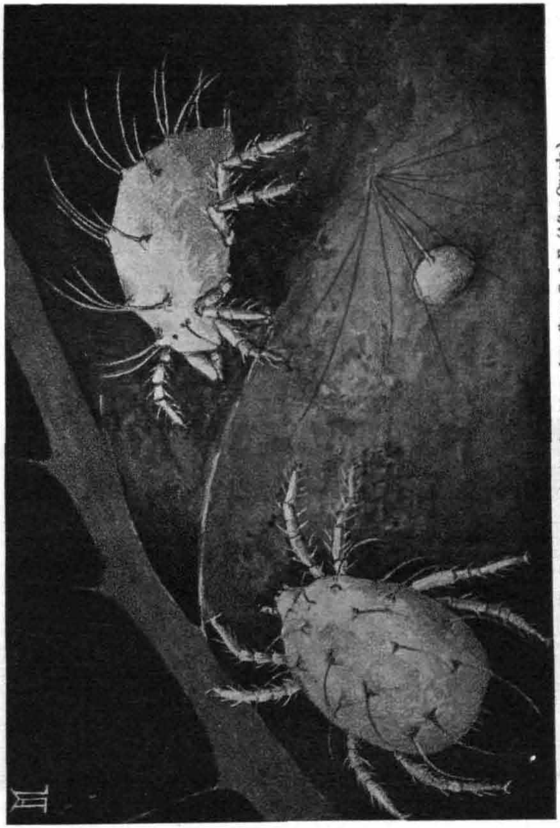

FIG. 19.—The European red mite, *Paratetranychus pilosus* C. & F. (After Quayle.)

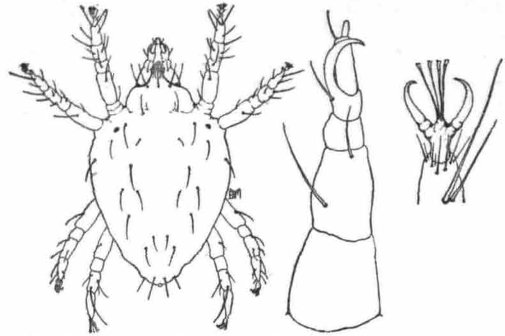

FIG. 20.—The terminal mite, *Caligonus terminalis* Banks. Palpus and end of foot at right. (After Quayle.)

FIG. 21.—Webs of the bamboo mite, *Stigmæopsis celarius* Banks, on bamboo leaves.

The broad-footed mite, *Schizotetranychus latitarsus* Ewing,[1] is a yellowish or reddish species, 0.36 mm. long with the tarsi broadly truncate at the tips. It works on the leaves of bamboo in Southern California and was probably introduced from China or Japan.

[1] *Jour. Econ. Ent.*, *10, 1917*, p. *498. Orig. desc.*

The apple mite, *Caligonus mali* Ewing,[1] is a yellow or reddish mite 0.30 mm. long, sparsely clothed with straight simple hairs. Its attacks produce a silvering of the leaves and it is responsible for serious injury to apple trees in some localities in Oregon.

The terminal mite, *Caligonus terminalis* Banks [2] (Fig. 20), is shiny bright red, 0.30 mm. long and half as wide. It occurs on the leaves of orange and lemon trees in Southern California, but is not a pest.

The bamboo mite, *Stigmæopsis celarius* Banks (Fig. 21), appears much like the red spider, but works under small, definite white webs on the leaves of bamboo. The plants suffer considerably from its attacks. The mite now occurs in Southern California, having evidently been imported with bamboo plants from Japan. This species is recorded from Florida.[3]

ERYTHRÆIDÆ.[4] Running Mites.

These are common, very active mites, larger than most species, usually red, very hairy, with long and slender legs, the hind pair sometimes more than twice the length of the body; cephalothorax large, body widest near the front. They are predaceous and the young are often attached to insects, while the adults are usually on the ground, stones, logs or trees over which they run very rapidly. All stages prey on other mites and on small insects.

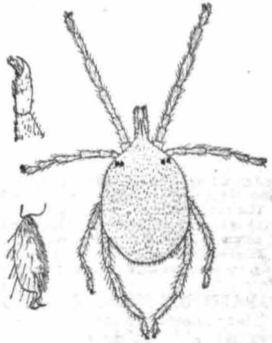

FIG. 22.—The red orchard mite, *Erythræus posticatus* Banks. Last joint of palpus left above; tarsus left below.

The red beach mite, *Erythræus arenicola* (Hall),[5] is a rather large bright red mite 0.78 mm. long, thickly covered with fine feathery hairs. It is common on the ocean beaches of Southern California, running rapidly over the dry hot sand above the high-water mark in search of prey.

Erythræus arvensis Banks is a large bright red, hairy mite occurring in Utah and neighboring states. It feeds upon small insects and has been observed devouring the eggs of the alfalfa weevil, *Phytonomus posticus* (Gyll.).[6]

Erythræus gracilipes (Banks) is a bright red mite, 1 mm. long, clothed with simple spines of the same length, predaceous on small mites and small insects. The writer has found this abundant on prune trees infested with the common red spider, *Tetranychus telarius* (Linn.) and Italian pear scale, *Diaspis piricola* (Del Guercio), upon which it was feeding. It also attacks the San José scale. The distribution includes California and Oregon.

Erythræus moestus (Banks) is a bright red, hairy mite 1.2 mm. long, which is often abundant on citrus trees in Southern California. It attacks young black scale and other small insects.

The red orchard mite, *Erythræus posticatus* Banks (Fig. 22), is a bright red mite which often assumes a purplish color in the older forms; 1.5 to 2 mm. long; body covered with

[1] *Jour. Econ. Ent.*, 10, 1917, p. 499. Orig. desc.

[2] *P. C. Jour. Ent. and Zoöl.*, 6, 1914, p. 57. Orig. desc.

[3] N. Banks, Rept. 108, U. S. Dept. Agr., 1915, p. 38.

[4] N. Banks, Rept. 108, U. S. Dept. Agr., pp. 38–41, 1915.

[5] This species was described in the genus *Rhyncholophus* which is now replaced by *Erythræus*.

[6] Bul. 112, Bur. Ent., U. S. Dept. Agr. 1912, p. 33.

long hairs. This species is common in citrus and deciduous fruit orchards throughout California and feeds chiefly upon the eggs and young of the armored scales including red scale, yellow scale, purple scale, Italian pear scale, and San José scale.

TROMBIDIIDÆ. Harvest Mites or Chiggers.

These are red mites with two rather distinct body divisions, the cephalothorax bearing the first two pairs of legs, and the abdomen bearing the last two pairs; mandibles chelate; last joint of the last pair of legs not shorter or only slightly shorter than the penultimate joint; body hairy; palpi swollen, 5-jointed; legs 7-jointed; 2 claws. These mites, like the preceding family, are predaceous. The larvæ are commonly taken on insects and in many localities they often attack humans causing an irritating rash. This is particularly true in the Middle Western and Southern States during haying season. These annoying larvæ are variously known as chiggers, red bugs, and by many other names, but rarely attack man in the Western States.

The locust mite, *Eutrombidium trigonum* (Hermann) (*Ottonia locustarum* Walsh),[1] is the common locust mite of the United States and Europe. It is a large bright red species. The young are distinguished by the bifurcated coxal spurs and the four transparent lobes on the cephalic border of the front dorsal shield. They are often taken on the body and wings of grasshoppers, crickets, katydids, and mantids, and do not attack humans. The adults feed upon grasshopper eggs. In the West this species has been recorded only from Oregon, but it is probable that the mite frequently taken on grasshoppers in California is the same.

The little angel, *Trombidium magnificum* Lec.,[2] is a large, dark, red, hairy species 5 to 8 mm. long often appearing in immense numbers after rains on the mesas of Arizona, New Mexico, Texas, and Mexico. The Mexicans call them "angelitos," little angels.

The superb mite, *Trombidium superbum* Banks,[3] is similar to *T. magnificum* Lec. but has several patches of white hairs on the dorsum causing it to appear spotted white. It occurs in Arizona, New Mexico, and Texas.

The Pacific red mite, *Trombidium pacificum* Banks, is a small dark red species 2.2 mm. long, occurring in ants' nests and under stones in California, Oregon, and Washington.

PARASITIDÆ (GAMASIDÆ). Parasitic Mites.

These mites have hard, coriaceous bodies; rather short legs; are eyeless; normally with chelate mandibles which often may be completely withdrawn into the body; hypostome evident and bifid; thin plate above the mouth known as the epistome is present.

Most of the larvæ are six-legged, but in *Pteroptus* they are born with eight legs. Some of these mites are parasitic on beetles and other insects, others occur in ants' nests, a few species attack birds, while still others live on decaying animal or vegetable matter or on fungi and other minute plants. The food of many is unknown.

The chicken mite, poultry mite, red mite, or roost mite, *Dermanyssus gallinæ* (De Geer)[4] (Fig. 23), is a small red, pear-shaped mite, 0.6 to 0.9 mm. long which is a serious pest to poultry and often attacks people working about poultry houses. The mites hide during the day in cracks or crevices under the roost supports, in the nests, litter, and other places

[1] H. E. Ewing and A. Hartzell, *Jour. Econ. Ent.*, 11, 1918, p. 262. Banks lists this as *Microtrombidium locustarum* (Riley).
[2] *Proc. Acad. Nat. Sci. Phil.*, 1852, p. 145. Orig. desc.
[3] *Proc. Ent. Soc. Wash.*, 12, 1910, p. 2. Orig. desc.
[4] H. P. Wood, Bul. 553, U. S. Dept. Agr., Aug. 10, 1917.

in the poultry houses and yards, where the small white eggs are laid, and the young and adults come forth to attack the fowls at night. They breed rapidly and unless controlled make the houses uninhabitable. It is a cosmopolitan pest found throughout the world, but is more troublesome in the warmer regions. The fire ant, *Solenopsis geminata* Fab., is reported by Wood as destroying these mites. For control see chicken tick.

The bird mite, *Dermanyssus hirundinis* (Hermann), is larger than the chicken or poultry mite, averaging from 1 to 1.4 mm. in length; otherwise it appears much the same and is just as troublesome to poultry.

The fly mite, *Macrocheles muscæ* Ewing,[1] is a very small, dark yellowish-brown mite which attaches itself to the ventral surface at the base of the abdomen of the house fly, *Musca domestica* Linn., and is carried about while feeding on the host. It is reported from Oregon and New York, but undoubtedly has a wide distribution.

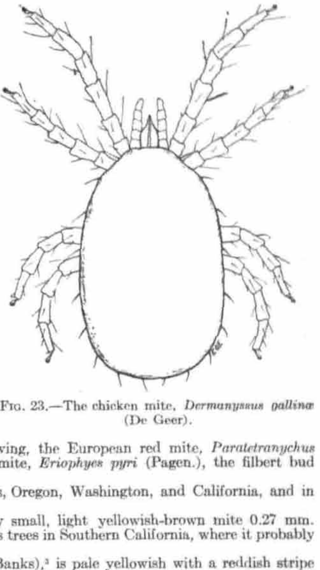

FIG. 23.—The chicken mite, *Dermanyssus gallinæ* (De Geer).

The predaceous mite, *Sejus pomi* Parrott, is a pale, oval species 0.4 mm. long, depressed above, and sparsely covered with short curved hairs. It is an important predator on many injurious mites, destroying the eggs, young, and adults of such species as the red spider, *Tetranychus telarius* (Linn.), the two-spotted mite, *T. bimaculatus* Harvey, the yellow mite, *T. flavus* Ewing, the European red mite, *Paratetranychus pilosus* C. & F., the pear leaf blister mite, *Eriophyes pyri* (Pagen.), the filbert bud mite, *E. avellanæ* Nal., and others.

It occurs in the Pacific Coast States, Oregon, Washington, and California, and in the Eastern part of the United States.

Hypoaspis armatus Ewing[2] is a very small, light yellowish-brown mite 0.27 mm. long, which occurs on the leaves of citrus trees in Southern California, where it probably feeds upon young scale insects.

The mouse mite, *Parasitus frontalis* (Banks),[3] is pale yellowish with a reddish stripe on each side meeting in front; curved dorsal spines; second pairs of legs much enlarged to grasp hairs of host; length 1.3 mm. It infests the mouse in California.

Parasitus californicus (Banks)[4] is light yellow with paler legs. It preys on mites, springtails, and other small insects and occurs in California.

Hologamasus inornatus Ewing is common on red clover in Idaho and feeds on the brown mite, and other mites.

The fungus mite, *Uropoda essigi* Banks, is a small, smooth, shining, hard mite, oval convex in shape and dark brown in color. The legs are short and armed with short stout spines. The mites move slowly and have been taken by the writer on the fruit of avocado which was on the ground and somewhat molded, and at the bases of aster plants among the decaying leaves at the surface of the ground. It occurs in Southern California and feeds upon fungi.

[1] *Ent. News*, 24, 1913, p. 452. Orig. desc.
[2] *Jour. Econ. Ent.*, 10, 1917, p. 499. Orig. desc.
[3] *Proc. Ent. Soc. Wash.*, 12, 1910, p. 3. Orig. desc.
The genus *Gamasus* is antedated and replaced by *Parasitus*.
[4] *Proc. Cal. Acad. Sci.*, 3, 1904, p. 368. Orig. desc.

ORIBATIDÆ. Beetle Mites.

These mites are characterized by having a hair or setæ arising from a pore near each posterior corner of the shoulder of the cephalothorax. They are coriaceous, shining, and convex oval, and because they resemble minute beetles, are known as beetle mites. They are often very dark in color and normally occur on the ground among decaying vegetation, wet leaves or moss on decaying logs, and on the trunks of trees. As a whole they are of little economic importance, although some species are injurious to grass and grain crops. Their frequent occurrence in greenhouses and orchards warrants the inclusion of the commonest species.

The tree mite, *Galumna arborea* Banks, is an oval, robust, shining dark brown mite. It is often abundant on trees and shrubs growing in greenhouses, lathhouses, and nurseries, as well as in the orchards. The mites collect in large numbers in the fall and early winter in protected places usually at the bases of the leaf petioles or on the bark, and probably feed upon fungous material, as no damage results from their presence. It occurs in Southern and Central California.

Oribella modestus Banks occurs under the bark of walnut, fruit, and other trees in California.

Eremæus modestus Banks [1] is a dark reddish-brown species abundant among the lichens on the trunks and limbs of citrus trees in Southern California.

The hieroglyphic mite, *Hermannia hieroglyphica* Hall,[2] is brown with black markings The dorsum is roughly and deeply sculptured. It has been taken under black scale on citrus trees of Southern California, where it was evidently in hiding.

TARSONEMIDÆ. Soft-Bodied Mites.

This small family includes mites of great importance to animal and plant life, which they attack. The bodies are soft, flat, pale in color, and clothed with few rather stout spines. The mouthparts are suctorial and the palpi barely visible.

The legs are short, the first two and last two pairs widely separated, composed of five or six segments, the front tarsi with one claw, the remainder with two claws and often a sucker.

The ventricose mite, *Pediculoides ventricosus* (Newport), is the most troublesome to man, although it is often very destructive to certain insect pests. The mites are pale yellow, the largest being less than 1 mm. long. The male retains its slender shape, but the female, which is ovoviviparous, swells to an enormous spherical body due to the development of the eggs in the abdomen. The young not only hatch within the female, but attain their complete development therein so that they mate shortly after birth. Normally the mites feed upon insects and are commonly found in stored grain products, attacking the larvæ of the Angoumois grain moth, *Sitotroga cerealella* (Oliv.), the granary and the rice weevils, *Sitophilus granarius* (Linn.), and *S. oryza* (Linn.), *Thecodiplosis piniradiatæ* (S. & M.), and the joint worms, *Harmolita* spp. and their parasites, the larvæ of the bean and pea weevils, the larvæ of many wood-boring beetles, the parasites of coccids, and in fact a very great variety of insects. From these sources the mites find their way to people and cause severe itching and pain by producing lesions of the skin. Men working in the harvest fields or handling stored grain are often seriously attacked. In the rearing of hymenopterous parasites for the control of scale insects in California, this mite not only destroyed all of the parasites in some insectaries, but also attacked the attendants.

The mites may be controlled in granaries and storehouses by fumigating with carbon disulfid, sulfur fumes, and hydrocyanic acid gas. Mercurial ointment is recommended for treatment of infested humans.

[1] *Proc. Ent. Soc. Wash.*, 12, 1910, p. 9. Orig. desc.
[2] *P. C. Jour. Ent.*, 3, 1911, p. 646. Orig. desc.

The grass mite, *Siteroptes carnea* Banks,[1] is a slender, bright red mite, 0.28 mm. long, with stout legs and tarsi ending in three forked claws. It is often present in enormous numbers on grasses producing "silver top," in New Mexico, Utah, and Colorado.

The cyclamen or pallid mite, *Tarsonemus pallidus* Banks (*T. approximatus* Banks),[2] is a plant infesting mite of considerable importance as a greenhouse pest. The mites are pale transparent green, elliptical, with mouth parts projecting slightly in front, female 1.1 mm., and the males 0.75 mm. long. The females are oviparous and parthenogenetic. The eggs are elliptical, pearly white, and laid in masses in moist dark places usually in curled or distorted leaves. The young are transparently white and mature rapidly. The young and adults feed upon the leaf and flower buds and upon the young tender leaves, causing discoloration, curling, and distortion. The injury to the plants and flowers results often in great loss to the grower. The adults are present in the greenhouses throughout the year, but are most abundant in the winter. The chief injury in greenhouses in most places is to cut and potted flowers such as cyclamen, snapdragons, geraniums, and chrysanthemums. As a pest to such the mite is known in different parts of the United States. In the West it is recorded from California, Oregon, and Washington. In Southern California, however, the mite occurs in the citrus orchards but is not a pest. J. F. Lamiman has found it injurious to strawberry plants at Berkeley, California.

Control in the greenhouses may be effected by using a 1% lime-sulfur solution with the addition of casein or flour paste as a spreader. Tender plants may be more safely treated with tobacco and soap, 1 part of 40% nicotine sulfate to 600 parts of water, with the addition of 5 pounds of fish oil soap to 100 gallons of above.

Tarsonemus assimilis Banks[3] is closely related to and may prove to be *T. pallidus* Banks. It occurs on citrus trees in Southern California and though reported from red scale it is probably a plant feeder.

TYROGLYPHIDÆ.[4] Cereal Mites, Root Mites.

This is another small family of mites, which are chiefly injurious to cereal and food products and plants. They are mostly very minute, almost colorless, with the body clothed with a few long spine-like hairs. The legs end in one claw and usually a sucker. During most of the life the mites are free moving, but there is a resting migrating stage or condition known as the hypopus during which they take no food. In the hypopial stage there is a definite area of suckers on the venter by which the mite attaches itself to insects for transportation. After arriving at a suitable place it releases its hold, molts, feeds, and develops into the adult. Several of the cereal-infesting mites also attack humans handling such materials, and produce a severe dermatitis called "grocers' itch."

The mites which infest cereals and cereal products, dried fruit, and so forth, require a considerable amount of moisture for development, and articles kept dry or stored in a dry, well ventilated place are less susceptible to attack than if placed in dark damp places. The use of heat at 135° F. is very effective in the control of the mites. Carbon disulfid appears to be the best fumigant because the heavy vapors readily penetrate through sacks of compact grain or flour and is specially recommended for grain in bins.

[1] *Proc. Ent. Soc. Wash.*, 7, 1905, p. 140. Orig. desc. This mite is placed in the genus *Pediculoides* by some authors.

[2] *Proc. Ent. Soc. Wash.*, 4, 1898, p. 295. Orig. desc.

N. Banks, *P. C. Jour. Ent. and Zoöl.*, 6, 1914, p. 60. *T. approximatus* Banks. Orig. desc. The male of this species appears sufficiently distinct to consider it a separate species.

P. Garman, Bul. 208, Maryland Agr. Exp. Sta., June, 1917.

G. F. Mozenette, *Jour. Agr. Research*, 10, No. 8, Aug. 20, 1917, p. 373.

[3] *P. C. Jour. Ent. and Zoöl.*, 6, 1914, p. 60. Orig. desc.

[4] Nathan Banks, Tech. Ser. No. 13, Bur. Ent. U. S. Dept. Agr., 1906.

The rat mite, *Histiostoma tarsalis* Banks,[1] occurs in nests of rats in California. The hypopial stage attaches to the rat flea, *Ceratophyllus fasciatus* (Bosc.), for transportation from nest to nest.

The dried fruit mite, *Carpoglyphus passularum* Hering, is a pale white species 0.40 to 0.50 mm. long, of European origin, which is being distributed in this country and occurs in California. It lives in and feeds on dried fruits such as figs, raisins, apples, prunes, as well as cured hams, and even the pollen paste of bees.

The cereal mite, *Tyroglyphus americanus* Banks[2] (Fig. 24), is a pale mite from 0.27 to 0.40 mm. long, with hairs at the posterior end of body nearly as long as the body. It is common throughout the country and infests grain and cereal products, flax, mustard, cotton and other seeds. It occurs on stored lemons and on decaying plums, prunes, oranges, and lemons in Southern California.

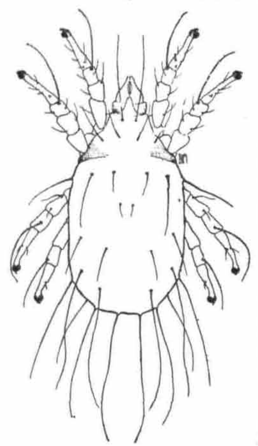
FIG. 24.—The cereal mite, *Tyroglyphus americanus* Banks. (After Quayle.)

The grain mite, *Tyroglyphus longior* Gervais, has the long body hairs plumose and long tarsi. Like the former species it also attacks grains and cereal products as well as drugs, seeds, cheese, dried fruits, and prepared foods of animal and vegetable origin. It is an introduced European species. A variety *castellani* Hirst., infests copra in the orient, and produces "copra-itch" on humans handling copra materials. It is likely to be met with in shipments of such products coming into our Western ports.

The cheese mite, *Tyroglyphus siro* (Linn.), is commonly found infesting cheese, but also attacks flour, and cereal products, dried meats, and mattresses and upholstery stuffed with hair. It often attacks the hands and arms of grocers and produces a dermatitis known as "grocers' itch." It is a European species common in America. Besides fumigation as recommended for *T. americanus* Banks, whole cheeses infested may be cleaned by dipping in or painting with carbon disulfid and fumigating the storeroom with the same.

The mushroom mite, *Tyroglyphus lintneri* Osborn, is 0.30 to 0.38 mm. long with simple body spines. It is at times a very serious pest to mushrooms, is very easy to distribute with the spawn, and difficult to eradicate. It occurs in the East and in California and Oregon. In Southern California it is at times abundant on citrus trees. Cleaning the beds and sterilizing the new dirt and manure, and the use of clean spawn are important. The use of a 2% solution of commercial lime-sulfur solution readily destroys the mites if applied directly to the beds with a sprinkling can or a sprayer.

The flour mite, *Aleurobius farinæ* (De Geer),[3] has but few short body hairs. It is a cosmopolitan species common in flour, cereals and cereal products, cheese, seeds, mustard, peas, and is often a serious pest in flour mills, granaries, and warehouses where such materials are manufactured or stored. It is also responsible for a dermatitis in man.

Members of the genus *Monieziella* are predaceous on mites and small insects, chiefly scale insects. *Monieziella angustus* Banks is three or four times as long as wide, averaging 0.30 to 0.35 mm., and with short legs. It is common in central California feeding upon scale young insects, chiefly the ivy or oleander scale, *Aspidiotus hederæ* (Vall.) and the greedy scale, *Aspidiotus camelliæ* Sign. *Monieziella bipunctata* Ewing is pale yellow with brown markings, 0.22 mm. long with a pair of long posterior setæ. It occurs in Oregon.

[1] *Proc. Ent. Soc. Wash.*, 12, 1910, p. 12. Orig. desc.
[2] Tech. Ser. No. 13, Bur. Ent. U. S. Dept. Agr., 1906, p. 16. Orig. desc.
[3] This species has been separated from the genus *Tyroglyphus* because of the enlarged front legs of the males.

Histiogaster xylophaga Banks [1] is a small elongated species with no long tarsal hairs and with the front legs larger than the hind. It burrows in the decayed stems of alfalfa in Arizona.

The bulb or eucharis mite, *Rhizoglyphus hyacinthi* Boisd. (*R. echinopus* F. & R.) (Fig. 25), is usually white but frequently has two large amber or brownish spots on the body. The length varies from 0.55 to 0.75 mm. The mites are usually found in colonies and because of their oval shape and sluggish movements are often mistaken for eggs. Most often they occur in rotted areas under or above ground, always away from the light. They are responsible for serious injury to many plants and particularly to bulbs such as freesia, hyacinth, lilies, narcissus, and onions; and also woody stems under ground like asparagus and peony. Besides the actual damage by burrowing into the

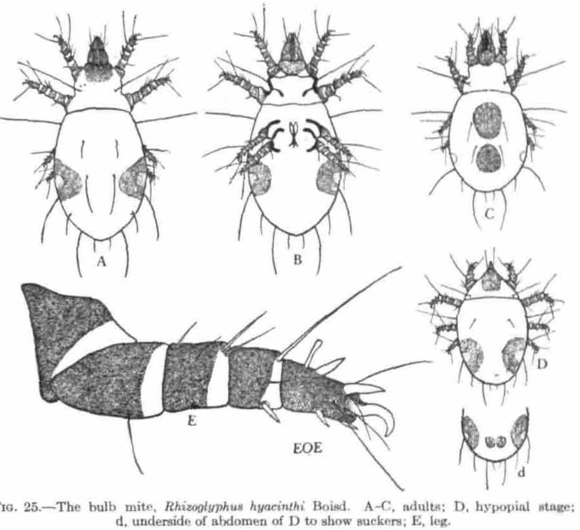

FIG. 25.—The bulb mite, *Rhizoglyphus hyacinthi* Boisd. A–C, adults; D, hypopial stage; d, underside of abdomen of D to show suckers; E, leg.

tissues, the mites carry fungous and bacterial diseases which often do a great deal more damage. This mite is cosmopolitan and has been distributed throughout this country on bulbs. It is chiefly a greenhouse pest in Eastern States, but along the Pacific Coast it occurs on many bulbs and plants in the fields and gardens. Thoroughly drying out the bulbs after dipping in a 2% lime-sulfur solution for 30 minutes cleans them under most conditions.

The elongate mite, *Rhizoglyphus elongatus* Banks, is a small white mite occurring on the roots of grapevines in California, associated with phylloxera.

Rhizoglyphus longitarsis Banks var. *californicus* Hall has been reported injurious to the bark of apple trees in Southern California.[2] This injury, however, seems doubtful.

[1] *Proc. Ent. Soc. Wash.*, 14, 1912, p. 98. Orig. desc.
[2] H. V. M. Hall, *P. C. Jour. Ent. and Zoöl.*, 4, 1912, p. 751. Orig. desc.

The root mite *Rhizoglyphus rhizophagus* Banks,[1] is of much the same appearance, but somewhat larger than the bulb mite, varying from 0.65 to 0.80 mm. long, and has longer tarsi and larger front legs. It occurs on the roots of apple trees in Montana, cottonwood stumps in Missouri, on the crowns of red clover, and on potatoes in Idaho, and on onions and grape roots in California.

The balsam root mite, *Rhizoglyphus sagittatæ* Faust,[2] is a pale yellow mite, much like the two preceding, which feeds upon the tender leaves of the balsam root, *Balsamorrhiza sagittata* in Montana.

The beet mite, *Rhizoglyphus tarsalis* Banks, occurs on sugar beets, in dried figs, and in the nests of ground bees in California.[3]

CANESTRINIIDÆ. Insect Mites.

This is a small family of mites which are parasitic on insects. The bodies are robust, the legs short and ending in a sucker, the mandibles are chelate and retractile, the palpi simple and filiform. Many of these mites occur on beetles. A single species in our district feeds on the eggs of scale insects.

The coccid eating mite, *Hemisarcoptes coccisugus* Lignières (*Acarus malus* Shimer), occurs in Europe, Canada, and the Eastern States, and has been introduced into British Columbia. It feeds upon the eggs or young of the oyster shell scale, *Lepidosaphes ulmi* (Linn.), the San José scale, *Aspidiotus perniciosus* Comst., and others.

ANALGESIDÆ. Bird Mites.

The bird mites form a large family of which there are large numbers in all regions, although little is known concerning the individual species. Collectively they are small, soft-bodied, somewhat wrinkled mites, without eyes, with long and short bristles on the body and legs. Some larvæ have but 4 legs but most have 6 until after the first molt. They live on birds, feeding on the epidermal scales, feathers, and so forth, and are not considered as pests, although when present in great numbers they must be annoying to the host.

Proctophyllodes reticulifer Trouessart, *Pteronyssus bifurcatus* Hall and *Analges cremidonotus* Trouessart occur in California.

LISTROPHORIDÆ. Hair-Clasping Mites.

These very small mites appear much like the bird mites and live on small mammals.

The beaver mite, *Schizocarpus mingaudi* Trouessart, occurs in the West having been reported in Washington and California and undoubtedly occurs in neighboring states as well. It is an ectoparasite on beaver. The males have the third pair of legs much enlarged and the last pair very small, and while the nymphal female has but one pair of legs, the mature female has the normal four pairs.

SARCOPTIDÆ. Itch, Sarcoptic, or Scab Mites.

The itch mites are minute, white, somewhat flattened hemispherical in shape, with undivided body and minute transversely striated surface, embracing a few hairs and bristles. The legs are short and the two anterior pairs are distant from the two posterior pairs. The palpi are short, three-jointed, and close to the rather prominent rostrum. These mites are ectoparasitic on mammals, including man, and on some birds. The

[1] Tech. Ser. 13, Bur. Ent., U. S. Dept. Agr., 1906, p. 21. Orig. desc.
[2] *Entom. News*, 29, Nov., 1918, p. 336. Orig. desc.
[3] Tech. Ser. 13, Bur. Ent. U. S. Dept. Agr., 1906, p. 20. Orig. desc.

females burrow into the skin and the young hatching from the eggs make other burrows causing a serious itching diseased condition in man known as acariasis and in domestic animals as scabies and mange. Their work not only produces serious disorders in and under the skin, but causes the hair and wool to fall out and greatly lessens the vitality of the host.

The itch mite, *Sarcoptes scabiei hominis* (Hering),[1] attacks human beings and causes great annoyance. It is not present, however, except under unusual or unsanitary conditions, as in city slums and in armies. Cleanliness is a sure preventive. It is controlled by first scrubbing with soap and hot water and then making several applications of sulfur ointment. The clothing should also be boiled. Dogs, ferrets, and rabbits are also infested by the same mite.

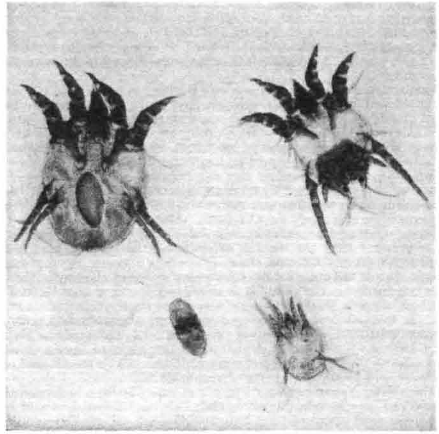

FIG. 26.—The horse mange mite, *Sarcoptes scabiei equi* Gerlach. (After Herms.)

The Norwegian itch mite, *Sarcoptes scabiei crustosæ* Fürstenberg, causes a coarse hard crust of the skin. It infests humans but is very uncommon in this country, although well known in many parts of Europe.

The horse mange mite, *Sarcoptes scabiei equi* Gerlach[2] (Fig. 26), infests the horse, ass, mule and is transmissible to man, for a short time. It causes dry mange, symptomatic mange or epizoötic mange, which starts at the withers and spreads to the sides, back, shoulders, and neck. It is cured by dipping the entire host three or four times in commercial lime-sulfur and nicotine dip or in miscible oil or crude oil emulsion or in coal-tar-creosote dips.

[1] Cecil Warburton, "Sarcoptic Scabies in Man and Animals." *Parasitology*, 12, 1920, p. 265.
P. A. Buxton, *Parasitology*, 13, 1921, p. 146.
The sarcoptic mites burrow into the skin of the hosts while the psoroptic mites do not burrow.

[2] P. A. Buxton, *Parasitology*, 13, 1921, p. 114.

The dog mange mite, *Sarcoptes scabiei canis* Gerlach, attacks the dog and may be acquired by man. It is particularly bad on long-haired dogs and those having damp sleeping quarters and invades the head and any part of the body. It is likely to occur on dogs anywhere.

The hog mange mite, *Sarcoptes scabiei suis* Gerlach, attacks the hog and is communicable to man and dog, but soon dies on all excepting the hog. It is the largest Sarcoptid, being from 1/50 to 1/60 inch long. It may start on any part of the body and cover the entire surface, but is more often found on the head around the eyes, ears, and nose. It is spread by direct contact and is controlled by coal-tar-creosote or miscible oil dips.

The sheep sarcoptic mite, *Sarcoptes scabiei ovis* Megnin, causes black muzzle or face mange and attacks parts free from wool, chiefly the face, but may also occur between the forelegs, on the leg joints, and on the belly. It must not be confused with the psoroptic mite which causes sheep scab and is much more serious.

The bovine sarcoptic mite, *Sarcoptes scabiei bovis*,[1] does not appear to be a well-defined species, although such a mite occurs on cattle throughout this country and works on the inner surfaces of the thighs, root of the tail, brisket, and may even cover the entire body surface, causing a dry and hard scabby skin. It is controlled as is the horse mange mite. During the year 1925 over 200,000 cattle were dipped in Arizona alone for the control of this mite.

The sheep scab mite, *Psoroptes communis ovis* Hering,[2] is a small mite which does not burrow into the skin, but which is the greatest pest which sheepmen have to deal with. With its sharp mandibles it punctures the skin and starts the blood which forms the scab. The mite works around and enlarges the scabby areas. The wool sticks together in greasy masses. Heavy losses of sheep due to its attacks occur in autumn or early winter. It occurs throughout the world and is found in the United States and in some of the Western States, but quarantine and dipping campaigns have largely eradicated it in this country. It is combated by dipping twice at intervals of from 10 to 14 days in warm lime-sulfur or in nicotine and sulfur dip. Professor C. P. Gillette has used 8% kerosene emulsion effectively in Colorado. The miscible oils should be valuable for this purpose. During 18 months ending July, 1922, the California State Dept. of Agriculture announced that the disease necessitated the dipping of 2,102,000 sheep at a cost of $105,000.00 in California alone.

The symbiotic scab or tail mange mite, *Chorioptes bovis equi* (Hering), like the psoroptic mites does not burrow in the skin. It is most often found around the tail and causes tail mange which spreads slowly, but may also occur on the legs and is transmissible to all cattle. It is much less common and important than common scab and should receive the same treatment. This mite is also listed by J. Lamarre,[3] as the horse hock mange mite, *Chorioptes equi* Gerlach, which infest the hocks of horses producing great irritation and causing the hair to fall and sores to follow. As a cure Banks recommends 1 part of carbolic acid to 15 or 20 parts of vegetable oil.

The cat scabies mite, *Notoedres minor* Fürst. var. *cati* (Hering), begins on the ears and head of the cat and may invade the whole body. It may infest dogs and is communicable to man for a short space of time, but soon dies out. S. B. Freeborn has found it seriously infesting and even killing wild gray squirrels in California (January 21, 1921).

The chicken body or depluming mite, *Cnemidocoptes lævis* Railliet (*C. gallinæ* Railliet),[4] causes body or depluming scabies of poultry and other birds. The small oval mites burrow at the base of the feathers causing scales, great irritation, and loss of feathers. The mite is most prevalent in summer and greatly reduces the vitality and egg-laying of chickens. Unless checked the entire flock may soon become infested. Control consists in the use of dry sodium fluoride. H. P. Wood[5] recommends dipping the fowls, ruffling the feathers while immersed and ducking the heads several times in a solution

[1] M. Imes, *Farmers' Bul.* 1017, U. S. Dept. Agr., Dec., 1913, p. 10.
This variety appears never to have been officially named, so the author is omitted.
[2] M. Imes, *Farmers' Bul.* 713, U. S. Dept. Agr., Apr. 17, 1916.
M. C. Hall, *Farmers' Bul.* 1150, U. S. Dept. Agr., Dec., 1920, p. 10.
Also listed as *Psoroptes equi* var. *ovis* Hering.
[3] *Parasitologie des animaux domestiques*, Paris, 1912, p. 936.
Chorioptes symbiotes var. *equi* Railliet is also listed as a synonym.
[4] C. Warburton, *Parasitology*, 12, 1920, p. 293.
[5] *Jour. Econ. Ent.*, 12, 1919, p. 402.

of $^2/_3$ ounce of chemically pure sodium fluoride, 2 ounces of sulfur, $^1/_3$ ounce of laundry soap and 1 gallon of water. This mixture also kills lice.

The scaly leg mite, *Cnemidocoptes mutans* Robin and Lanquentin, is a very minute, almost round, somewhat flattened whitish mite which works under the epidermal scales of the legs causing a deformation of the scales and spongy crusts, giving rise to a condition known as scaly leg or rumble foot. It attacks domestic fowls, small domestic birds, and wild game birds. Control is effected by dipping the legs directly in kerosene or distillate or by using 1 part of kerosene to 2 parts of vegetable oil.

CYTOLEICHIDÆ. Lung Mites.

This is a small family containing but few species of very small soft mites closely related to the *Sarcoptidæ*, but have smaller mouth parts. One species, **the California ground squirrel mite,** *Cytoleichus banksi* Wellman and Wherry,[1] occurs in California and the West. It is convex oval with faint corrugations on the epidermis and is 0.20 mm. long and 0.15 mm. wide. It occurs in great numbers in "small, grayish, rounded, slightly raised tubercles on the lungs and in the deep lung tissues," a single mite in each tubercle of the California ground squirrel, *Citellus beecheyi beecheyi* (Richardson).

DEMODICIDÆ. Follicle Mites.

These are minute transparent elongated mites with somewhat enlarged cephalothorax, with 3-jointed legs; short rostrum; and long narrow striated abdomen. They inhabit the sebaceous glands and hair follicles of man and other mammals causing swellings, tubercles, and abscesses, often producing intense itching.

The follicle mite, *Demodex folliculorum* Simon, inhabits the sebaceous glands of man and is wrongly confused with "blackheads" on the face and other parts of the body. It is cosmopolitan but is rarely met with except in very unsanitary surroundings.

The demodectic mange mite, *Demodex folliculorum bovis* Stiles, produces lumps on the skin of cattle varying in size from a mustard seed to a pea, or even larger. These lumps may spread over the entire surface and cause abscesses which break and discharge pus. They start most often on the neck and shoulders, and besides the severe irritation to the host, ruin the hides for leather. It is almost impossible to remove the trouble, but frequent dippings as for mange will hold it in check.

The dog follicular mite, *Demodex folliculorum canis* Tulk., is parasitic on the dog and produces small tubercles or swellings in the skin which become pustular and are very annoying and sometimes even fatal to the host.

The hog follicular mite, *Demodex phylloides* Csokor, lives in the skin of hogs causing small white tubercles the size of a pea or less, which appear to cause no irritation to the host.

ERIOPHYIDÆ (*PHYTOPTIDÆ*). Phytoptid, Blister, Erinose and Gall Mites.

The members of this family are exceedingly small, microscopic mites with elongated bodies and but two pairs of legs at the anterior end. The bodies are made up of a short cephalothorax bearing the legs, a pair of short 3-jointed palpi, and the rostrum; while the abdomen, which is often finely striated with concentric lines, bears a number of long spines and a posterior truncate telson from which arise two caudal spines. At the tip of the abdomen is also a sucker for holding to the surface of the plant. All are plant feeders, some living freely upon the surface of the leaves, fruit, and tender twigs; others forming a felty surface; while many form

[1] *Parasitology*, 3, 1910, p. 421. Orig. desc.

peculiar shaped galls with an opening on the ventral surfaces of the leaves. The felty areas and hairy entrances and linings of the galls are caused by a multiplication and concentration of the surface hairs of the plant and act as a protection for the eggs and mites. The work is serious to plant life causing malformations and often complete defoliations. The host plants are largely deciduous and evergreen trees and shrubs. The winter is spent in immature and mature stages under the bud scales. Upon the opening of the buds in the spring the mites begin feeding upon the tender leaves and continue on these throughout the summer and fall and often attack the blossoms, fruit, and limbs as well. In some cases the opening buds are so distorted by the great numbers of mites feeding on them in the spring as to be greatly enlarged and swollen, producing what is known as big bud which results in death for those so attacked. Practically all of these mites may be controlled by lime-sulfur solution applied in the fall, spring, or summer.

The eggs are spherical and laid singly or in groups, and hatch in from one to two weeks. The young mature in from two weeks to a month. There is continual breeding during the spring, summer, and fall months resulting in a number of uneven broods. The food is taken from the epidermal cells and is thought to consist largely of oils. Defoliation is not so likely to result from their attacks as is deformation and scabbing of the foliage and fruit.

Control is best affected with dormant strength, 1 to 10, commercial *lime-sulfur solution preferably, in the fall of the year just after the leaves* have mostly fallen and the mites are seeking hibernating quarters under the bud scales; or in the spring of the year just as the buds are beginning to swell and expose the mites so that they may be reached with the spray. In either event it is necessary to spray thoroughly to drench all of the last year's growth around the edges and in the tops of the trees where the mites are most abundant.

There are six genera recognized by Banks which he separates as follows:[1]

1.—Number of abdominal striæ equal on dorsum and venter............ *Eriophyes*
Number of abdominal striæ on dorsum about half as many as on venter........ 2

2.—Dorsum with middle area highly arched.................................. 4
Dorsum of an even curve.. 3

3.—End piece or telson of abdomen plainly separated............... *Anthocoptes*
End piece or telson of abdomen not plainly separated............ *Phyllocoptes*

4.—Some of dorsal abdominal striæ extend backward spinelike on the side *Oxypleurites*
Dorsal rings not extending spinelike...................................... 5

5.—Dorsum of abdomen with two longitudinal furrows................ *Epitrimerus*
Dorsum without furrows .... *Tegonotus*

The writer is familiar with three of the above genera, which include a large number of Western species of interest and economic importance.

The pear leaf blister mite, *Eriophyes pyri* (Pagenstecher) (Fig. 28), may be used to illustrate the general life history and methods of control. The work of this mite (Fig. 27), makes its presence easily distinguishable.

[1] Rept. No. 108, U. S. Dept. Agr., 1915, p. 136. Also see Bul. 283, N. Y. Agr. Exp. Sta., Geneva, Dec., 1906, by P. J. Parrott, H. E. Hodgkiss, and W. J. Schoene.

Young pear leaves are so affected as to produce reddish or dark brown spots which become darker with age and may be so numerous as to cover

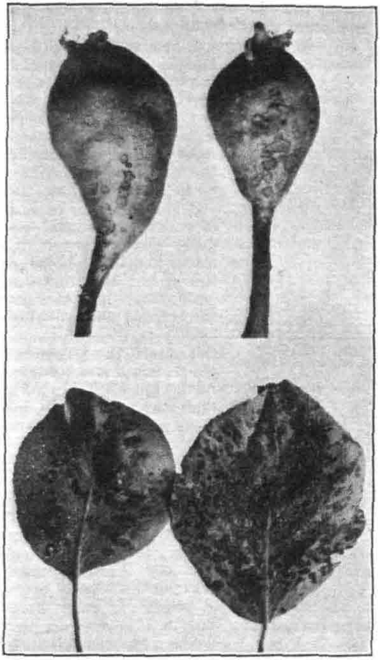

FIG. 27.—Work of the pear leaf blister mite, *Eriophyes pyri* (Pagen.), on fruit and leaves of pear.

the entire surface. On the apple the lesions are the color of the leaves until they turn dark with age. The young shoots suffer most. Fruit of the pear is also attacked and the early lesions on the small pears are at first reddish, then brown, and later develop into a scab-like area. The fruit becomes malformed and where the infestation is serious a large percentage of de-

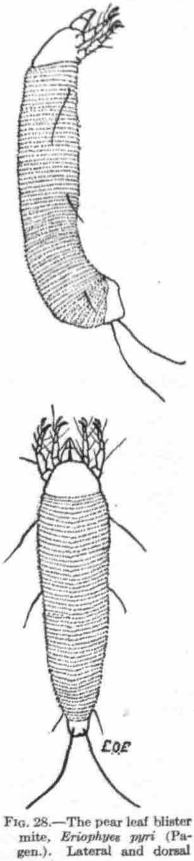

FIG. 28.—The pear leaf blister mite, *Eriophyes pyri* (Pagen.). Lateral and dorsal aspects.

formed fruit occurs which becomes a total loss. The mites are very minute and can be seen only with the aid of a hand lens or microscope. The body is long and slender, transversally striated, with a few rather long hairs, and is transparently white. The mites pass the winter on the trees under the bud scales in an immature or mature stage. They become active in the spring when the buds begin to open and begin to attack the leaves just as soon as they appear. Weldon reports the females laying eggs under the bud scales and hatching in the spring so that the young begin to work as soon as the buds open.[1] Eggs are normally laid by the females on the surface of the leaves among the leaf hairs and the feeding of young and adults produces the erinose on the leaves and the scabbing of the fruit. Many uneven generations appear through the summer and fall; thus feeding and breeding continue until the leaves begin to fall in late autumn. At this time the mites work their way to the buds and many perish with the falling leaves.

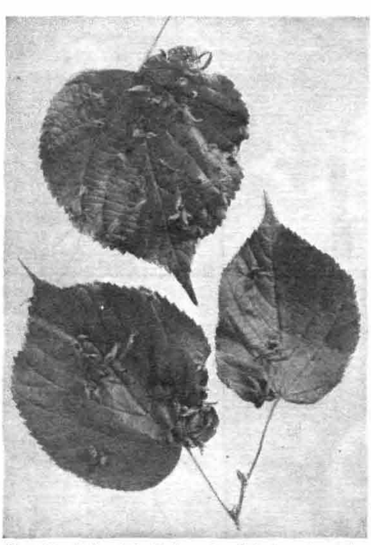

FIG. 29.—Galls of the linden mite, *Eriophyes abnormis* (Garman), on linden.

The pear leaf blister mite has accompanied pear nursery stock to all parts of the world and is present wherever the trees are grown. It was introduced into the United States prior to 1870 and occurs in practically every state and in Canada. In the Western States and British Columbia it is very common and is most serious on pears grown in the warmer interior valleys. However it also attacks the apple, mountain ash, shad bush, and cotoneaster.

The only recorded natural enemy is the predaceous mite, *Sejus pomi* Parrott, which is not a factor in its control.

The control which has been well worked out and which is very successful consists in applying dormant commercial lime-sulfur solution 1 to 10, or its equivalent of dry material, either during the late fall when nearly all of the leaves have dropped, or in the spring when the buds are beginning to open. Fall sprayings give the best results in the warmer regions

[1] *Mthly. Bul.*, Calif. Hort. Com., 4, 1915, p. 219.

because they can usually be effected without interference of rains, and are rapidly gaining preference over spring treatment in California, although the latter gives good results where careful work is done.

The linden gall mite, *Eriophyes abnormis* (Garman) (Fig. 29), causes bright red, cone-shaped galls from ¼ to ⅛ inch long on the upper surfaces of the leaves of linden and basswood trees.[1] Besides the Eastern and Middle Western States it occurs in British Columbia and California.

The filbert bud mite, *Eriophyes avellanæ* (Nalepa) (Fig. 30), works in the developing buds of filberts and hazelnuts causing "big bud," an enlargement of the buds in the spring of the year which often results in their complete destruction. Hundreds of mites have been found in a single bud in March, the infested trees producing scarcely any leaves and no nuts. The only infestation occurs in a restricted area in Oregon. Filbert buds received by the writer swarmed with the bud mites and were being preyed upon by the predaceous mite, *Sejus pomi* Parrott. The mites were determined by Dr. H. E. Ewing. For control use the same measures as recommended for the pear leaf blister mite.

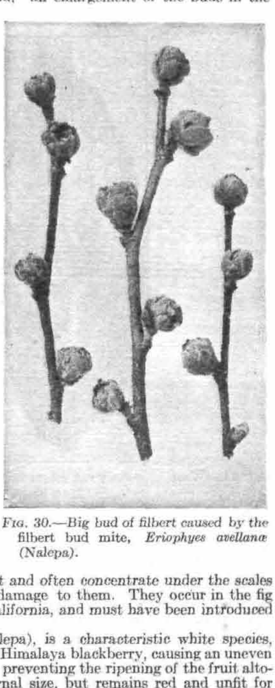

Fig. 30.—Big bud of filbert caused by the filbert bud mite, *Eriophyes avellanæ* (Nalepa).

The walnut blister mite, *Eriophyes tristriatus* (Nalepa) *erineus* (Nalepa),[2] attacks the lower surfaces of the leaves of the English walnut causing a large dense yellow or brownish erineum (Fig. 31), which produces a large blister-like swelling on the upper surface and a concave area on the under surface of the infested leaves. It is a common, though not injurious mite throughout California and Oregon and probably occurs in other Western states. This mite may also work on the green husks of the nuts causing a russeting or blackening of the tissues. Another species confused with the above is *E. tristriatus* (Nalepa), which is pinkish rather than white and forms small globular galls the size of a pea on the upper surfaces of the leaves of the black walnut tree. The latter is recorded on walnut trees in Germany.

The fig mite, *Eriophyes fici* Ewing,[3] is a minute, white elongated mite which overwinters in the buds and the fruit of the caprifigs and works in the fruit of edible figs during the summer. All the common varieties except the black mission were found infested, the mites causing a faint russeting of the interior. As the fruit ripens the mites work out and often concentrate under the scales at the opening. As yet we can attribute no damage to them. They occur in the fig growing districts of the San Joaquin Valley, California, and must have been introduced from Europe with nursery stock.

The blackberry mite, *Eriophyes gracilis* (Nalepa), is a characteristic white species, which works in the developing drupelets of the Himalaya blackberry, causing an uneven ripening of the different drupelets of a berry or preventing the ripening of the fruit altogether, which may obtain full or even abmornal size, but remains red and unfit for use. So general may the infestation become that not a single berry in a patch will fully ripen and turn black. Only the Himalaya variety is attacked, but the distribu-

[1] The galls always open on the lower surfaces of the leaves.

[2] It is difficult to distinguish the variety of this species from the true specific form.

[3] Determined by Ewing as a new species and given the above MS. name.

tion of the mite occurs throughout many parts of California. It may have been introduced with the original plants from Asia. The mites hibernate in the buds and are with the original plants from Asia. The mites hibernate in the buds and are effectually controlled by applying a 4% or 8% lime-sulfur solution in the spring just prior to blossoming, or a spray composed of 5 pounds of wettable sulfur to 100 gallons of water any time throughout the summer. Either method stops the effects of the mites at once. Specimens were determined by Dr. H. E. Ewing, but there is some doubt as to the specific name.

The apple leaf mite, *Eriophyes malifoliæ* Parrott, is reported in the west only from British Columbia. It attacks the apple leaves much like the pear leaf blister mite. The work is often mistaken for apple scab. The control measures are the same as for the pear leaf blister mite.

FIG. 31.—Work of the walnut blister mite, *Eriophyes tristriatus* (Nalepa) *erineus* (Nalepa), on leaves of English walnut.

The cottonwood mite, *Eriophyes populi* Nalepa, produces large irregular knot-like enlargements on the twigs and small limbs about the buds of cottonwood and poplars in the Eastern States and in Colorado.

The plum leaf gall mite, *Eriophyes pruni* Schœne,[1] causes pimples which develop into galls on the leaves of American plum trees in Montana. The mites hibernate under the bud scales and may be effectively controlled by a dormant lime-sulfur spray in the late fall after the leaves fall or in the spring when the buds are opening.

The plum twig gall mite, *Eriophyes padi* Nalepa, causes distortions and galls on plum leaves much like the preceding species, and is controlled the same way. It occurs in Montana.[2]

The pine needle mite, *Eriophyes pini* (Nalepa), is often abundant and very injurious to the foliage of Monterey pine and Torrey pine along the coast from central to southern California.

[1] D. B. Swingle and H. E. Morris, Bul. 123, Mont. Agr. Exp. Sta., Feb., 1918, p. 167.

[2] R. A. Cooley, Bul. 102, Mont. Agr. Exp. Sta., Dec., 1914, p. 197.

According to Banks, *E. padi* Nalepa, may possibly be the same as *E. pruni-crumena* Walsh.

Eriophyes phlœocoptes Nalepa produces round galls at the bases of the buds and new growth of plum trees in Europe and the United States, but is not yet found in this region.

The Juniper mite, *Eriophyes ramosus* Hodgkiss,[1] is a narrow, pinkish, or dark red mite which greatly deforms the fruit of *Juniperus pachyplœa* in Arizona.

The currant gall mite, *Eriophyes ribis* Nalepa, is a serious European pest which attacks the buds causing them to swell and die before opening. It is particularly injurious to black currants but also attacks native varieties. It occurs in British Columbia[2] having probably been imported from England. English writers claim that it cannot be controlled with lime-sulfur, but that it succumbs to two dormant treatments of crude carbolic acid emulsion.[3] Miscible oil should also be effective.

The maple erinose mite, *Eriophyes ryderi* Banks, causes a pale yellow or brown erineum on the undersides of maple leaves. The writer has taken it in California on the broad leaf maple.

The willow gall mite, *Eriophyes salicicola* (Banks),[4] is dull yellow or reddish with rather short, stout bodies 0.10 mm. long. If causes great numbers of small galls on both surfaces of willow leaves, being often very abundant on the terminal shoots. It occurs in California and Colorado.

The wild cotton blister mite, *Eriophyes thurberiæ* Banks,[5] produces folded galls on the leaves of wild cotton, *Thurberia thespesioides*, which is often severely injured by it in the mountain canyons of Southern Arizona. It is feared that this mite may in time spread to cotton.

Grape erinose mite, *Eriophyes vitis* (Landois), causes erinose of the vine. The mites are pale white and considerably wider anteriorly. They work on the undersides of the leaves producing an erineum which first appears yellow and afterwards turns various shades of brown. The mites hibernate under the bud scales and are ordinarily controlled by spring and summer applications of flowers of sulfur commonly used for mildew. This species is European and occurs wherever European varieties of grapes are grown. It is common in California and other Western States but is never a real pest.

The David peach mite, *Phyllocoptes amygdalina* Banks,[6] is a short, robust tiny mite 0.18 mm. long which feeds on the leaves of the David peach, *Prunus* (*Amygdalus*) *davidiana* Franch, in Southern California.

The artemisia gall mite, *Phyllocoptes californica* (Hall),[7] causes white or pinkish swellings on the undersides of the leaves of California sage, *Artemisia californica* Less., in Southern California.

The peach silver mite, *Phyllocoptes cornutus* Banks,[8] is a pinkish mite, 0.13 mm. long which lives freely and feeds on both sides of the leaves but more often on the upper surfaces, producing a silvering of the tissues. The results of the work may be quite serious at times to peach trees although the mite also attacks prune and cherry trees as well. It hibernates under the bud scales and can be controlled by dormant lime-sulfur sprays in November or in the spring. Summer sprays as recommended for the common red spider, *Tetranychus telarius* (Linn.), prove effective in controlling the mites after they have begun work on the leaves. This mite occurs in the Eastern States and in California.

The rust or silver mite, *Phyllocoptes oleivorus* (Ashmead) [*Eriophyes oleivorus* (Ashmead)][9] (Fig. 32), is the well known rust mite of the orange and the silver mite of the lemon. The minute yellow mites work on the surface of the fruit, leaves and the bark of the young limbs, destroying the oil and epidermal cells producing a russeting and

[1] *Jour. Econ. Ent.*, 11, 1918, p. 149. Orig. desc.

[2] *Can. Ent.*, 52, 1920, p. 136.

[3] A. L. Lees, *Ann. Rept.*, Agr. & Hort. Research Sta., Long Ashton, Bristol, 1917, p. 37.

[4] There are evidently two species of *salicicola*, one is Banks' species placed in the genus *Cecidobia* and the other is *E. salicicola* Garman. The western species in question is apparently the former.

[5] *Proc. Ent. Wash.*, 16, 1914, p. 44. Orig. desc.

[6] *Proc. Ent. Soc. Wash.*, 14, 1912, p. 99. Orig. desc.

[7] *P. C. Jour. Ent.*, 2, 1910, p. 280. Orig. desc.

[8] *Proc. Ent. Soc. Wash.*, 7, 1905, p. 141. Orig. desc.

[9] *Can. Ent.* 11, 1879, p. 160. Orig. desc. Ashmead spells the species, *oiliioorus*, probably intending it to be *oilivorus*, referring to its feeding on the oil cells of the fruit. The above spelling, however, is the accepted form.

hardening of the epidermis. It was introduced into California about 1889 from Florida, but is of little economic importance in the State, having become established only in parts of San Diego County, although it has been reported in Santa Barbara County. It produces the characteristic silvering of the lemon, but only rarely russets the oranges in this State. It is effectively controlled by using either 2% commercial lime-sulfur solution or wettable sulfur, or a combination of these as used for the common red spider.

The rusty leaf mite, *Phyllocoptes schlechtendali* Nalepa, works on the surface of the leaves, fruit, and bark of young growth, causing a russeting or silvering of the leaves

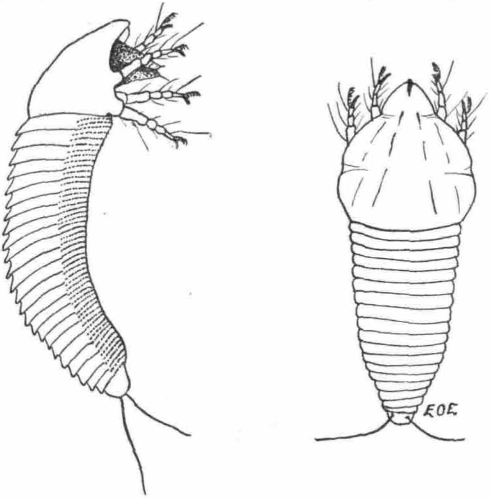

FIG. 32.—The rust or silver mite, *Phyllocoptes oleivorus* (Ashmead). Lateral and dorsal aspects.

and incrustations, and cracking of the fruit and the tender bark. Nursery stock often suffers at the tender tips. Pear leaves, besides being rusty and silvery, are also curled and blackened. Apple and pear are the preferred hosts but prune may also become infested. The adults are larger and broader than those of the pear leaf blister mite with which it may be associated. Although generally distributed in the Pacific Coast Region from British Columbia to California, it is a pest only in the warm and dryer sections. It is a European species which is also known in the Eastern part of the United States. The control is the same as for the pear leaf blister mite.

The pear leaf rust mite, *Epitrimerus piri* (Nalepa), also works on the surface of the leaves and may be associated with the pear leaf blister mite and the rusty leaf mite. It is smaller than either and has the dorsum of the back highly arched. It causes a russeting of the leaves which may partially or entirely envelop the surface particularly on the undersides. Infested leaves later become blackened. The pear is the only recorded host. This mite like most of the other orchard infesting species was imported from Europe and occurs in various parts of the United States. In the West it is found in the warmer pear growing districts of California and is usually held in perfect control by the usual sprayings for the pear leaf blister mite.

CHAPTER III

CLASSIFICATION OF INSECTS

INSECTA or HEXAPODA (Class)

Insects

Subclasses and Orders [1]

APTERYGOTA (APTERYGOGENEA) (Subclass). Apterous Insects.

1. Thysanura	1. Thysanura.....	Silverfish, Bristletails
	2. Entotrophi.....	Campodeids, Japygids
2. Collembola	3. Protura.........	Proturids
	4. Collembola.....	Springtails, Snow Fleas, etc.

PTERYGOTA (PTERYGOGENEA) (Subclass). Largely Winged Insects

3. Dermaptera	11. Dermaptera....	Earwigs
4. Orthoptera	9. Saltatoria.......	Grasshoppers, Katydids, Crickets
	12. Diploglossata...	Hemimerids
	14. Blattariæ.......	Cockroaches
	10. Phasmida.......	Phasmids, Walkingsticks
	15. Mantodea.......	Mantids
5. Isoptera	16. Isoptera.........	Termites, White Ants
6. Zoraptera	17. Zoraptera.......	Zorapterans
7. Embiidina	8. Embiodea.......	Embiids
8. Corrodentia	18. Corrodentia....	Psocids, Book Lice, Bark Lice
9. Mallophaga	19. Mallophaga....	Biting Bird Lice
10. Ephemerida	5. Ephemerida....	Mayflies
11. Odonata	6. Odonata........	Dragonflies, Damselflies
12. Neuroptera	26. Neuroptera.....	Lacewings
	24. Megaloptera....	Sialids, Dobson Flies
	25. Raphidides.....	Raphidids, Serpent Flies
13. Plecoptera	7. Perlariæ.......	Stoneflies
14. Mecoptera	27. Panorpatæ.....	Scorpion Flies
15. Trichoptera	28. Trichoptera....	Caddice Flies
16. Thysanoptera	13. Thysanoptera...	Thrips
17. Anoplura	20. Siphunculata...	Sucking Lice
18. Homoptera	33. Homoptera.....	Cicadas, Leafhoppers, Treehoppers, Aphis, Scales, etc.,
19. Hemiptera	32. Heteroptera....	True Bugs
20. Coleoptera	21. Coleoptera.....	Beetles, Weevils
21. Strepsiptera	22. Strepsiptera....	Strepsipterans
22. Diptera	29. Diptera........	Flies
23. Siphonaptera	30. Suctoria........	Fleas
24. Lepidoptera	31. Lepidoptera....	Butterflies, Moths
25. Hymenoptera	23. Hymenoptera...	Sawflies, Horntails, Ants, Wasps, Bees, etc.

[1] The orders in the second column are those by A. Handlirsch and are numbered numerically as he uses them; however, the subclasses are reversed in order. The above arrangement is neither chronological nor morphological, but for convenience of students.

KEY TO ORDERS OF ADULT INSECTS

1. Entirely apterous or with inconspicuous vestigial wings....... 2
   With rudimentary or fully developed wings....... 22

2. With biting and chewing mouth parts....... 3
   With piercing and sucking mouth parts....... 18

3. *Mouth parts retracted within the head so that only the apices are visible*....... 4
   Mouth parts free, not retracted within the head....... 5

4. Abdomen composed of 10 or 11 segments; many forms with long caudal appendages (Bristletails and Campodeids); others with abdomen terminating in immovable forceps (Japygids)....... **Thysanura** p. 55
   Abdomen composed of not more than 6 segments, with eversible sacs on the venter of the first segment; with or without a springing apparatus at the caudal end (Springtails)....... **Collembola** p. 58

5. Head prolonged into a beak (Scorpion Flies)....... **Mecoptera** p. 170
   Head normal, not prolonged into a beak....... 6

6. *Small soft or leathery insects, louse-like in form*....... 7
   Small to large insects usually with well-chitinized exoskeleton, not louse-like in form....... 8

7. Antennæ with not more than 5 joints; parasitic on birds and mammals (Biting Bird Lice)....... **Mallophaga** p. 126
   Antennæ with more than 5 joints; not parasitic (Bark and Book Lice)....... **Corrodentia** p. 123

8. Abdomen not constricted at the base; cerci present....... 9
   Abdomen constricted at the base, cerci absent (Wingless Ants and other related insects)....... **Hymenoptera** p. 756

9. Tarsi 3–4 jointed....... 10
   Tarsi 2-jointed, cerci not segmented....... **Zoraptera** p. 120
   Tarsi 3-jointed, basal joint of front tarsi swollen (Embiids)....... **Embiidina** p. 121

10. Hind legs enlarged for jumping (Wingless Katydids, etc.)....... **Orthoptera** p. 67
    Hind legs normal, not specially enlarged....... 11

11. Prothorax much longer than the mesothorax, front legs enlarged for grasping prey (Mantids)....... **Orthoptera** p. 67
    Prothorax not greatly lengthened, forelegs not enlarged....... 12

12. Cerci present, antennæ with 15 or more joints....... 13
    Cerci absent, antennæ usually 11-jointed....... **Coleoptera** p. 369

13. Cerci with more than 3 joints....... 14
    Cerci with from 1–3 joints....... 15

14. Body flattened and oval; head inflexed; prothorax oval. (*Blattariæ*) (Cockroaches)....... **Orthoptera** p. 67
    Body elongate; head normal; parothorax quadrate (*Grylloblattidæ*)....... **Orthoptera** p. 67

15. Tarsi 5-jointed; body long and very slender (*Phasmida*) (Walkingsticks) **Orthoptera** p. 67
    Tarsi 2- to 4-jointed, body not linear....... 16

16. Front tarsi normal, not greatly enlarged....... 17
    Front tarsi with the first joint greatly swollen....... **Embiidina** p. 121

17. Tarsi apparently 4-jointed, cerci with 2–6 joints; antennæ usually with more than 9 joints (Termites) . . . . **Isoptera** p. 112
Tarsi 2-jointed, cerci unsegmented; antennæ 9-jointed; minute species **Zoraptera** p. 120

18. External parasites on birds and mammals 19
Not parasitic on birds and mammals 21

19. Body strongly compressed laterally; small jumping insects (very rudimentary wings often present) (Fleas) . . . . **Siphonaptera** p. 624
Body not compressed laterally 20

20. Antennæ inserted in pits not visible from above (*Pupipara*) . . . . **Diptera** p. 523
Antennæ exserted and plainly visible from above (Sucking Lice) . . . **Anoplura** p. 192

21. Apical joint of tarsi terminating in a bladder-like organ, well-defined claws absent (Thrips) . . . . **Thysanoptera** p. 179
Apical joint of tarsi not bladder-like, terminating in well-defined claws (Plant Lice, Scale Insects, etc.) . . . . ***Homoptera*** p. 199

22. With but two wings 23
With four wings 25

23. Abdomen with caudal filaments 24
Abdomen without caudal filaments (Flies) . . . . ***Diptera*** p. 523

24. Halteres absent, many veins in wings (few Mayflies) . . . . **Ephemerida** p. 139
Halteres present, a simple forked vein in wings, minute fragile insects (most male *Coccidæ*) . . . . **Homoptera** p. 199

25. The fore and hind pairs of wings unlike in structure, the fore wings thickened, leathery or horny and the hind wings membranous 26
The fore and hind pairs of wings alike in structure and membranous 30

26. The fore wings reduced to slender club-shaped appendages; minute insects ***Strepsiptera*** p. 522
The fore wings leathery except the tips which are membranous; mouth parts for piercing and sucking (Bugs) . . . . **Hemiptera** p. 332
The fore wings of the same texture throughout 27

27. Fore wings leathery or horny, without veins and serving as covers for the hind wings 28
Fore wings leathery or parchment-like with a network of veins 29

28. The fore wings short, never entirely covering the abdomen; the tip of the abdomen ending in a pair of movable forceps (Earwigs) . . . . **Dermaptera** p. 63
The fore wings partially or completely covering the abdomen; the tip of the abdomen without movable forceps (Beetles, Weevils) . . . . **Coleoptera** p. 369

29. Hind wings folded lengthwise like a fan beneath the fore wings; mouth parts for biting and chewing (Grasshoppers, Katydids, Crickets, etc.) . . . **Orthoptera** p. 67
Hind wings not folded; mouth parts for sucking (Aphis, Leafhoppers, Treehoppers, Scales, etc.) . . . . ***Homoptera*** p. 199

30. Last tarsal joint terminating in a bladder-like organ, without claws; wings usually bordered with long fringes of hairs (Thrips) . . . . **Thysanoptera** p. 179
Last tarsal joint terminating with well-developed claws 31

31. Wings partially or more often entirely covered with scales; mouth parts for sucking (Moths and Butterflies) . . . . **Lepidoptera** p. 629
Wings transparent or thinly clothed with hairs 32

32. Mouth parts arising from the underside of the head back near the fore coxæ, enclosed *in a jointed rostrum and for sucking* . . . . ***Homoptera*** p. 199
Mouth parts normally situated at the front of the head 33

33. Wings with many longitudinal and cross veins, net-veined.................... 34
Wings with branching veins and few cross veins, not net-veined.............. 35

34. Tarsi with less than five joints.. 35
Tarsi 5-jointed.. 39

35. Antennæ inconspicuous, small, short, setiform................................ 36
Antennæ conspicuous, of many forms... 37

36. Fore and hind wings nearly equal in size; tarsi 3-jointed (Dragonflies, Damselflies)... **Odonata** p. 141
Fore wings much larger than the hind wings; tarsi 4-jointed (see 24) (Mayflies).. **Ephemerida** p. 139

37. Tarsi 2- or 3-jointed... 38
Tarsi 4-jointed; wings equal (Termites, White Ants)............. **Isoptera** p. 112

38. Fore pair of wings equal or narrower than the hind pair (see 43) (Stoneflies) **Plecoptera** p. 166
Fore pair of wings larger than the hind pair (see 44) (Bark Lice, Book Lice) **Corrodentia** p. 123

39. Abdomen with long, filiform, many jointed caudal filaments (see 24, 36, 45) (certain Mayflies).. **Ephemerida** p. 139
Abdomen without long, many jointed caudal filaments......................... 40

40. Head prolonged into a beak (Scorpion Flies).................. **Mecoptera** p. 170
Head not prolonged into a beak (Lacewings).................. **Neuroptera** p. 151

41. First joint of the front tarsi greatly swollen (Embiids)........ **Embiidina** p. 121
First joint of the front tarsi not greatly swollen............................ 42

42. Tarsi 2- or 3-jointed... 43
Tarsi 4- or 5-jointed.. 45

43. Hind wings smaller than the fore wings....................................... 44
Hind wings equal to or larger than the fore wings (see 38) (Stoneflies) **Plecoptera** p. 166

44. Cerci present; body less than 3 mm. in length (Zorapterans)..... **Zoraptera** p. 120
Cerci absent; body larger than above (see 38) (Book Lice, Bark Lice) **Corrodentia** p. 123

45. Abdomen with long many jointed filiform caudal filaments (see 24, 36, 39) (certain Mayflies).. **Ephemerida** p. 139
Abdomen without long many jointed caudal filaments.......................... 46

46. Prothorax heavily chitinized or horny; fore wings larger than the hind wings, the latter with but few simple veins; mandibles well developed; palpi short (Sawflies, Horntails, Wasps, Ants, Bees, etc.)................ **Hymenoptera** p. 756
Prothorax parchment-like or membranous; hind wings as large or larger than the fore wings, folded lengthwise and with many branching veins; fore wings naked or thinly clothed with hair; mandibles very small; palpi long (Caddice Flies) **Trichoptera** p. 172

CHAPTER IV

THYSANURA (Order)[1]

(*Thysanos*, a tassel; *oura*, tail)

Silverfish, Fish Moths, Bristletails

The members of this order have the bodies elongated, flattened, naked, or covered with scales; with long antennæ and anal appendages; and with styli on the ventral surface of some of the abdominal segments. For the most part they are minute or fairly large, attaining nearly an inch in length. They are diurnal and nocturnal in habits. The smaller forms are usually found in damp leaf mould or in soil rich with humus, while the larger forms inhabit dry leaves, grass, and buildings. They are quite active, running rapidly and jumping when disturbed. Their food is largely composed of dead vegetable matter, and with the exception of the house inhabiting forms, are of no importance. The main families of the order are:

1. Body covered with scales 2
   Body not covered with scales 3
2. Eyes small and far apart .... **Lepismidæ**
   Eyes large and close together .... **Machilidæ** p. 56
3. Caudal appendages straight, many jointed .... **Campodeidæ** p. 56
   Caudal appendages forceps-like .... **Japygidæ** p. 56

LEPISMIDÆ. Silverfish, Fish Moths or Bristletails.

The silver fish moth, *Lepisma saccharina* Linn., is a silvery-gray or brownish species 10 mm. long with long antennæ and three long and several short anal appendages. It is nocturnal and inhabits buildings, venturing out at night and moving with great swiftness. It feeds upon starchy materials and often does serious damage to book bindings and other materials fastened with paste or glue. It is generally distributed throughout the country. It may be controlled by sprinkling powdered pyrethrum, borax, or sodium fluoride in its runways, or by using a poison bait composed of one pint of flour and ½ ounce of white arsenic, thoroughly mixed with the addition of sufficient water to make a thin paste. This paste may be placed on tins or cards and located in cupboards on shelves and other places out of the reach of children and house pets.

The fire brat, *Thermobia domestica* (Packard) (*Lepisma*), is about the same size and general appearance as the preceding fish moth, but is decidedly mottled gray in color. It is generally distributed and common in buildings and often favors the hot bricks and stones around fireplaces and ovens, thus obtaining its common name. The feeding habits and control are the same as for the silver fish moth.

[1] G. C. Crampton, "The Orders and Relationships of Apterygotan Insects." *Jour. N. Y. Ent. Soc.*, 24, p. 267, Dec., 1916.
V. Willem, "Recherches sur les Collemboles et les Thysanoures." *Mem. cour. Mem. sav. etr. Acad. Roy. Belgique*, 58, pp. 1–144, 1900.
F. Silvestri, "Material for the Study of *Thysanuri*," 12–15, Portici, 1910. "New Genera and New Species of *Campodeidæ* of America." Portici, 1911.

Lepisma rubro-violacea Schött has a reddish-wine colored body covered with brownish scales. It is a very common species in California, Arizona, Lower California, and Mexico.
Lepisma reticulata Schött also occurs in California.[1]

MACHILIDÆ. Machilids.

Members of the genus *Machilis* are common and often abundant in dry leaves and grass during the summer and fall. There are many undescribed species in the West.

The orange fish moth, *Machilis aurantiacus* Schött, occurs in California and *M. orbitalis* Packard is recorded in Idaho and Washington.

CAMPODEIDÆ.[2] Campodeids.

The members of this family are very small, delicate white insects with long antennæ and a pair of long cerci. They live in the damp soil, under wet leaves, or in decaying vegetable matter where they feed on organic materials.

The mountain campodeid, *Campodea montis* Gardner, has thirty or more antennal segments and fourteen joints in the cerci which are nearly as long as the thorax and abdomen. The length of the body is 5 mm. It lives in the damp leaves and soil in the canyons and on the hills of Southern California.

Folsom's campodeid, *Campodea folsomi* Silvestri (Fig. 33, f), has from nineteen to twenty-two antennal segments and eleven segments in the cerci. The length of the body varies from 2.5 to 3 mm. It is recorded in California and Mexico.

Kellogg's campodeid, *Campodea kelloggi* Silvestri, has from twenty-one to twenty-two joints in the antennæ and from eleven to thirteen joints in the cerci. The body is 3.3 mm. long. It occurs throughout California.

Wheeler's campodeid, *Haplocampa wheeleri* Silvestri, has from sixteen to nineteen joints in the antennæ and but eight in the cerci. The length of the body is 3 to 3.5 mm. It has only been taken on Mt. Shasta, California.

Wilson's campodeid, *Eutrychocampa wilsoni* Silvestri, has from twenty to twenty-one antennal joints and ten joints in the cerci. There are large appendages on the claws and a peculiar flower-like pad between the claws. The length of the body is 2.6 mm. It is known to occur only in California and Arizona.

JAPYGIDÆ.[3] Japygids.

The members of this family are small, delicate, slender, flattened, white insects with short antennæ and a pair of brown forceps-like organs at the tip of the abdomen. Like the campodeids they inhabit the soil to considerable depths as well as damp leaves, rotten logs, and are found under bark of dead trees and under stones. They are most in evidence during the early spring months.

The American japyx, *Japyx americanus* MacGillivray, is 14 mm. long; forceps with two medium and five smaller tubercles on the inner margin of the right arm, and one very large, three medium and nine very small tubercles on the inner margin of the left arm, which is also broadest at the base. It occurs at Olympia, Washington.

The large japyx, *Japyx diversiunguis* Silvestri (Fig. 33, e), is 6 to 8 mm. long with twenty-six antennal segments and a pair of large teeth near the middle and a number of small ones basad on the forceps. It has been taken by the writer as deep as thirty inches in the soil as well as from under stones and damp leaves. It ranges throughout California from the coast to the top of the Sierras.

Hubbard's japyx, *Japyx hubbardi* Cook, is recorded from New Mexico only.

The Sonora japyx, *Evalljapyx sonoranus* Silvestri, has thirty antennal segments,

[1] H. Schött, *Proc. Cal. Acad. Sci.*, 2d Ser., 6, 1896, p. 192.
[2] R. E. Gardner, *P. C. Jour. Ent. and Zoöl.*, 6, 1914, p. 86.
[3] M. H. Swenk, "Synopsis of N. A. Species of *Japyx*." *Jour. N. Y. Ent. Soc.*, 11, 1903, p. 129.
A. D. MacGillivray, *Can. Ent.*, 25, pp. 174, 218, 1893.

and forceps with a single large and a number of small teeth basad of the middle. The length is 6 to 7 mm. It is common under stones in early spring in California and Arizona.

The diverse japyx, *Evalljapyx diversipleura* Silvestri, is much like the preceding but has only twenty-four antennal segments. It occurs in the region of Mt. Shasta, California.

The kindred japyx, *Evalljapyx propinquus* Silvestri, has from twenty-seven to twenty-eight antennal segments and many small teeth almost the full length of both forceps. The length of the body is 6.2 mm. It is recorded only in California.

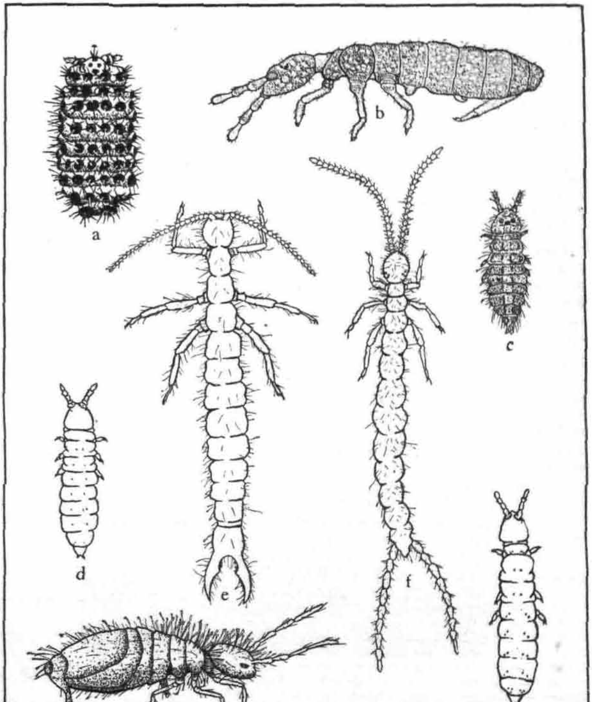

FIG. 33.—Thysanura. e, *Japyx diversiunguis* Silvestri; f, *Campodea folsomi* Silvestri. Collembola. a, *Neanura gigantea* (Tullb.); b, *Isotoma bidenticula* Guthrie; c, *Achorutes armatus* (Nicolet); d, *Onychiurus cocklei* (Folsom); g, *Entomobrya laguna* Bacon; h, *Onychiurus pseudarmatus* Folsom. (a, c, d, h, after Folsom; b, after Bacon).

CHAPTER V

COLLEMBOLA (Order)[1]

(*Colla*, glue; *embolon*, a bar—from the ventral glue sacs)

Springtails, Snow Fleas

These very small, almost microscopic insects are characterized by the fused abdomen showing not more than six segments; antennæ with from four to eight joints; and by the absence of caudal appendages. Many of them have a forked furcula or spring attached on the venter of the penultimate abdominal segment and folded beneath, for leaping, and are therefore known as springtails. On the venter of the first abdominal segment there is a pair of eversible sacs through which is exuded a sticky fluid, used to enable the insects to adhere to smooth surfaces.

Springtails inhabit moist localities and are found in rotten logs, wet leaf mold, and in the soil where the immature stages live mostly hidden from the light. The young are usually white or colorless, but when maturity is reached and they come to the surface and are exposed to the light, they assume dull or very bright hues. The adults usually appear during the winter months when great numbers may be seen on the surface of standing pools of water or on the snow from whence comes the name snow fleas. So abundant are they at times as to completely cover and color the snow. This winter appearance is apparently a mating reaction. They are vegetarian in habits, normally feeding on decayed organic materials amongst which they live, but they also at times attack planted seeds and young tender plants and prove to be pests in the gardens and fields as well as in the greenhouses. Besides their direct attacks on the plants, they may distribute fungous diseases. The insects may be killed in the soil by frequently watering with one part of 40% nicotine sulfate to 800 parts of water. The free use of tobacco dust and pyrethrum in the soil is also of value.

The order is composed of a large number of interesting members. The families may be separated as follows:

[1] Alex. D. MacGillivray, "N. A. *Thysanura*." *Can. Ent.*, 25, pp. 127, 313, 1893; 26, p. 105, 1894.
Harald Schött, "Beiträge zur Kenntniss Kalifornischer *Collembola*." *Bihang Kongl. Svenska-Akad. Handl.* Stockholm. Bd. 17, Afd. iv, No. 8, pp. 1–24, 1891; "N. A. *Apterygogenea*." *Proc. Cal. Acad. Sci.*, 2d ser. 6, p. 169, 1896.
Gertrude Bacon, "Arts. on California *Collembola*." *P. C. Jour. Ent. and Zoöl.*, 4, p. 841, 1912; 5, pp. 43, 202, 1913; 6, pp. 84, 137, 1914.
J. W. Folsom, "Subfamily *Tomocerinæ* of N. A." *Proc. U. S. Nat. Mus.*, 46, p. 451, 1914. "Subfamilies *Achorutinæ*, *Neanurinæ* and *Podurinæ*." *Proc. U. S. Nat. Mus.*, 50, p. 477, 1916. "Subfamily *Onychiurinæ*." *Proc. U. S. Nat. Mus.*, 53, p. 637, 1917.
C. F. Jackson, "Key to Families of *Collembola*." *Ohio Nat.*, 6, p. 546, 1906.
The writer is indebted to J. W. Folsom for the determination of most of the following species.

1. Furcula or spring wanting. . . . . **Aphoruridæ**
   Furcula or spring present. 2
2. Furcula arising from the venter of the antepenultimate abdominal segment. . . . . **Poduridæ**
   Furcula arising from the venter of the penultimate abdominal segment 3
3. Abdomen elongate, cylindrical, much longer than broad . . . . . **Entomobryidæ** p. 61
   Abdomen globular, almost as broad as long 4
4. Apical antennal segment long and ringed. . . . . **Sminthuridæ** p. 62
   Apical antennal segment short, with a whorl of hairs. . . . . **Papiriidæ** p. 62

J. H. Comstock places the first three families in the suborder *Arthropleona* and the last two in the suborder *Symphypleona*. The former have elongate bodies and the latter globose bodies.

APHORURIDÆ. Aphorurid Springtails.

Aphorura inermis (Tullberg) (*Lipura fimetaria* Packard) is known to damage the roots of young plants in Southern California.

Aphorura lutea Bacon and *A. montis* Bacon occur in leaves in the mountains of Southern California. The former is white and the latter yellow, each averaging 1.5 mm.[1]

Tullbergia collis Bacon occurs in Southern California.

The giant springtail, *Neanura gigantea* (Tullb.) (*Anura gigantea* Tullb.) (Fig. 33, a), is dark blue with robust broad flat body covered with large dark tubercles bearing several long hairs; antennæ shorter than the head; eyes composed each of five ocelli on a tubercle with long hairs; and the body from 3 to 5 mm. long. It inhabits Siberia, Alaska, British Columbia, Washington, Oregon, and California.

The serrate springtail, *Neanura serrata* Folsom, is mottled dark blue with the body tubercles black; antennæ and head equal in length, body 2.4 mm. long. This species occurs in damp soil under rotten logs, stones, boards, and leaves in Oregon.

Neanura ornata Folsom is an Alaskan species.

PODURIDÆ. Snow Fleas, Podurid Springtails.

The citrus springtail, *Achorutes citri* Bacon,[2] is a dull steel-blue species abundant on the surface of pools and on decaying oranges during the winter in the citrus orchards of Southern California.

The spiny springtail, *Achorutes longispinus* MacGillivray,[3] is purplish-black, hairy, and from 1 mm. to 1.25 mm. long. It occurs in New Mexico.

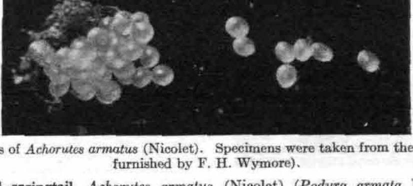

FIG. 34.—Eggs of *Achorutes armatus* (Nicolet). Specimens were taken from the soil. (Photo. furnished by F. H. Wymore).

The armed springtail, *Achorutes armatus* (Nicolet) (*Podura armata* Nicolet) (Fig 33, c), varies greatly in color. The young are white, while the color of the adults varies from dark brown, vinaceous, pale violet, greenish-gray to dark slate-blue, and a variety appears yellowish, marbled with purple. The eggs (Fig. 34), are transparent white

[1] *P. C. Jour. Ent. and Zoöl.*, 5, 1913, p. 44.
[2] *Ibid.*, 6, 1914, p. 166. Orig. desc.
[3] *Can. Ent.*, 25, 1893, p. 315.

and oval. It is a cosmopolitan species occurring over much of our Western territory but has been actually reported from only California and Colorado. This common species lives in the soil and attacks the planted and germinating seeds of beans, peas, tender greenhouse plants, particularly young ferns, and the young plants of wheat, rye, oats, barley, and mushrooms. It is often present in great numbers on the surface of rain pools in California in the winter and spring.

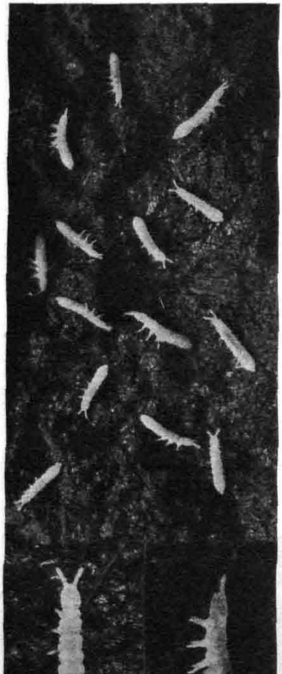

FIG. 35.—The seed springtail, *Onychiurus pseudarmatus* Folsom.

The false armed springtail, *Achorutes pseudarmatus* Folsom,[1] is black or mottled dark blue and much like *A. armatus* (Nicolet). It occurs from British Columbia to Southern California.

The wandering springtail, *Achorutes viaticus* Tullberg, is uniform dark blue, 2 mm. long, with antennæ shorter than the head. It is widely distributed throughout the world in Europe, Asia, South America, and North America. It has been taken at San Francisco, California. This species is useful in keeping the filter sand sharp and clean in sewage disposal plants.

Achorutes californicus Bacon occurs throughout California and has been taken on fungus at Berkeley by the writer.

Bacon's springtail, *Xenylla baconæ* Folsom,[2] is very dark blue or blackish with large anal spines; antennæ and head subequal; length of body 1.5 mm. It occurs on pools of water along the highways and in plowed fields of Southern California.

The maritime springtail, *Xenylla maritima* Tullberg, is grayish blue with the antennæ shorter than the head, and the length of the body 1.5 mm. It is a European and African species found in California.

Xenylla collis Bacon and *X. paludis* Bacon are California species.

The complex springtail, *Pseudachorutes complexus* (MacGillivray) (*Gnathocephalus complexus* MacG.), is dark blue with a lateral row of pale spots; from 3 to 4 mm. long; 8 eyes on each side; and anal spines absent. It occurs at Olympia, Washington.

Ewing's springtail, *Odontella ewingi* Folsom, is a robust species with dark oval eye patches; projecting and suctorial mouth parts; five eyes on each side; antennæ with 4 segments and shorter than the head; and the body 2 mm. long. It occurs at Corvallis, Oregon.

The dung springtail, *Onychiurus fimetarius* (Linn., Lubbock), is a pure white blind species from 1.8 to 2.1 mm. long occurring in Europe, Africa, Sumatra, and North America. In the United States it is widely distributed, but in the West is reported only from California.

The false dung springtail, *Onychiurus pseudofimetarius* Folsom, is a small slender white species 1.5 mm. long and closely akin to the preceding springtail. It is abundant

[1] *Proc. U. S. Nat. Mus.*, 50, 1916, p. 490. Orig. desc.
[2] *Proc. U. S. Nat. Mus.*, 50, 1916, p. 496. Orig. desc.

in damp soil, wet decaying leaves, and in rotten wood. It has proven to be injurious to germinating beans at Berkeley, California. It also occurs in Minnesota and Illinois.

The seed springtail, *Onychiurus pseudarmatus* Folsom (Figs. 33, h and 35), is a white slender species 3 mm. long and with the antennæ shorter than the head. It has proven to be a pest by destroying germinating purple vetch seed in Humboldt County, California. The species also occurs off the Alaska Coast and probably along the Pacific Coast from Alaska to California.

The golden snow flea, *Onychiurus cocklei* (Folsom) (*Aphorura cocklei* Folsom) [1] (Fig. 33, d), is a minute golden yellow species 1.8 mm. long, which becomes so abundant on the surface of the snow in British Columbia and Alaska, as to cover it with a golden carpet. It also occurs on the surface of water pools. It ranges at an altitude of 2,250 feet or more and may be found on snow as deep as two feet or even deeper, but exists only a few days, being carried off with the melting snow.

The water springtail, *Podura aquatica* Linn., is bluish-black with antennæ and legs reddish-brown; has 8 eyes on each side; and antennæ shorter than the head. It occurs on the surface of standing water and along the margins of ponds and streams of fresh and brackish water. It is found in Europe and America, having been recorded in Washington in the West.

ENTOMOBRYIDÆ. Entomobryid Springtails.

The two-eyed springtail, *Entomobrya binoculata* Schött,[2] is a white, very hairy species with the hairs on the head and prothorax enlarged at the tips. The antennæ are longer than the head, but not as long as the body which is 1 to 2 mm. It is widely distributed in California inhabiting wet rotten wood and damp decaying leaves.

The many spotted springtail, *Entomobrya multifasciata* (Tullberg) (*Podura multifasciata* Tullb.), is yellowish with well-defined dark markings around the margins of the middle of the body and an anchor-shaped dark mark on the head; body 1.5 mm. long; antennæ half as long as the body; eight pairs of eyes. It is abundant and widely distributed throughout the United States and is common in greenhouses.

The Laguna springtail, *Entomobrya laguna* Bacon (Fig. 33, g), is an interesting species because it lives under rocks along the ocean beach and may be captured at low tide, being completely submerged at high tide. It is easily recognized by the long spatulate hairs which arise from the head and body.

Other western species of *Entomobrya* are:

- *E. sexoculata* Schött. California, Mexico.
- *E. clitellaria* Guthrie. California, (Minnesota).
- *E. cæca* Schött. California.
- *E. atrocincta* Schött. California.
- *E. triangularis* Schött. California.

Isotoma besselsi Packard and *I. bidenticula* Guthrie (Fig. 33, b) occur under rocks at low tide along the Pacific Coast from the Arctic region to Southern California. Both species are from 0.75–1 mm. long and mottled dull brown.

The marsh springtail, *Isotoma palustris* (Müller), is 2.5 mm. long, brownish yellow with dark transverse bands and spots; thickly covered with short, stout brown hairs; antennæ a little longer than the head. It is often abundant under wet leaves, in wet soil, and on the surface of water pools throughout the United States and is common in the West. It also occurs in Europe and Siberia.

Isotoma titusi Folsom is a small dark slate-colored species very abundant on pools of water after rains, in California, Utah, and other Western States.

The green springtail, *Isotoma viridis* (Bourlet), is dark brown or yellow, mottled with purple, and may appear greenish. It is a large species from 5–6 mm. long with barbed hairs on the posterior part of the abdomen. It occurs throughout the United States.

Additional western species of *Isotoma* are:

- *I. elongata* MacGillivray. Colorado.
- *I. lacustris* Schött. California.
- *I. catena* Guthrie. California, (Minnesota).
- *I. palustris* (Müller) var. *balteata* Reuter. California.
- *I. aquæ* Bacon. Southern California.
- *I. aspera* Bacon. Southern California.
- *I. minima* Guthrie. California, (Minnesota).

[1] J. W. Folsom, *Can. Ent.*, 40, 1908, p. 199. Orig. desc.
[2] *Proc. Cal. Acad. Sci.*, 2nd ser. 6, 1896, p. 169.

Tomocerus flavescens (Tullberg) (*Macrotoma flavescens* Tullb.) is yellow with purplish or grayish markings. Two varieties are recognized by Folsom,[1] *T. americanus* Schött, which ranges from Alaska to New Mexico and *T. arcticus* Schött, occurring in Siberia, Alaska, British Columbia, Washington, and Oregon.

The common springtail, *Tomocerus vulgaris* (Tullberg) (*Macrotoma vulgaris* Tullb.), is a large purplish black species 4 mm. long, reported in Washington, Colorado, and the Eastern States.

Tomocerus bidentatus Folsom occurs in California and the East, and *T. minor* Lubbock occurs in Washington and the Eastern States.

Sinella curviseta Brook is opaque white to yellow with brown spots; two ocelli on each side of the head; and long slender antennæ. It occurs in damp soil and is often taken in and under flower pots and in flower beds in California. It is a European species.

The California springtail, *Tritomurus californicus* Folsom, is a blind yellow species often showing black markings where the scales are removed. It occurs in Santa Clara County, California.

Other western members of this family are:

Templetonia quadrioculata Schött. California.
Drepanura californica Schött. California.
Cyphodeirus albinus Nicolet. Europe, United States, California.
Pseudosira domestica Nicolet. Europe, California.

SMINTHURIDÆ. Sminthurids.

The following species have been described or listed from California by Harald Schött:

Sminthurus eiseni Schött is reddish or yellowish with black lines and markings on the head, thorax, and often a triangular area outlined on the posterior dorsum of the abdomen. The length is 1.5 to 2 mm.

Sminthurus luteus Lubbock.

Sminthurus niger Lubbock is black with the legs, antennæ, furculæ, and lines on the head white.

Sminthurus plicatus Schött is 1 mm. long and largely white with reddish cast and with dusky markings on the dorsum.

PAPIRIIDÆ. Papirids.

The Olympia papirid, *Papirius olympius* MacGillivray, is reddish, spotted dark brown; from 2–3 mm. long; and occurs at Olympia, Washington.

The spotted papirid, *Papirius maculosus* Schött, is 1.5 to 2 mm. long; whitish with ashy-gray or bluish markings on the legs and body and bright pale bluish antennæ. It occurs in California.

[1] J. W. Folsom, *Proc. U. S. Nat. Mus.*, 46, pp. 457, 460, 462, 1914.

CHAPTER VI

DERMAPTERA (Order)[1]

(*Derma*, skin; *pteron*, a wing)

Earwigs

The members of this order are small or medium-sized insects with simple or incomplete metamorphosis and biting mouth parts. They are elongate, flattened, with long slender antennæ, tough shiny exoskeleton, and a characteristic pair of strong movable forceps at the posterior tips of the abdomen. The earwigs are apterous or winged, the latter having a front pair of short, leathery tegmina or covers for the radially plaited hind wings which when folded may project slightly beyond the front pair.

They are usually found on the ground under stones or leaves, bark of dead logs and stumps, in the grass, and are largely vegetarian in their feeding habits, eating decayed or living plant material, although some species are predaceous on other insects.

Our native western species are of little importance at the present time, but an introduced species, the European earwig, may prove to be a garden pest in some localities.

KEY TO FAMILIES[2]

1. Second tarsal segment prolonged beneath the third.......................... 2
   Second tarsal segment not prolonged beneath the third.......................... 3
2. Second tarsal segment expanded, cordate.......................**Forficulidæ**
   Second tarsal segment not expanded.......................**Chelisochidæ** p. 65
3. Sixth segment of the antennæ usually clavate and always fully twice as long as the greatest width, usually more than twice as long, and, together with the fourth and fifth segments, generally longer than the basal segment..............**Labiidæ** p. 65
   Sixth segment of the antennæ fusiform and almost never twice as long as the greatest width, and, together with the fourth and fifth segments, rarely longer than the basal segment..**Labiduridæ** p. 65

FORFICULIDÆ

The European earwig, *Forficula auricularia* Linn.[3] (Figs. 36, 37), is a cosmopolitan species known in parts of North America. The color is

[1] This order is also known as Euplexoptera, and as Eudermaptera and by many authors as the family Forficulidæ of the order Orthoptera.

A. N. Caudell, *Jour. N. Y. Ent. Soc.*, 15, 1907, p. 166. *Proc. U. S. Nat., Mus.* 44, 1913, p. 595.

J. G. Rehn and M. Hebard, *Jour. N. Y. Ent. Soc.*, 22, 1914, p. 89.

[2] After A. N. Caudell, *Proc. U. S. Nat. Mus.*, 44, 1913, p. 595. Listed here as subfamilies.

[3] M. Hebard, *Ent. News*, 28, 1917, p. 323.

D. W. Jones, Bul. No. 566, Bur. Ent. U. S. Dept. Agr., 1917.

E. O. Essig, *Jour. Econ. Ent.*, 11, 1918, p. 338.

A. L. Lovett, *Crop. Surv. Pest. Bul.*, Ore. Agr. Exp. Sta. 1, No. 2, 1921, p. 78.

B. B. Fulton, *Sta. Circ.*, 29, Ore. Agr. Exp. Sta. 1922.

various shades of brown with the wing covers, legs, and antennæ paler. The forceps of the males nearly equal the distance from the tips of the folded wings to the end of the abdomen. The length varies from 11–15 mm. to the tip of the forceps. It lives among the leaves on the ground and lays the oval pearly-white eggs in masses in the soil. The young and adults are nocturnal, coming forth at night to attack many kinds of plants including flowers, ornamentals, fruit trees, vegetables, grains, and grasses.

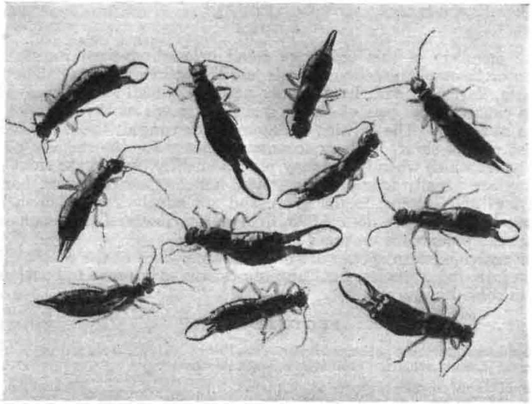

FIG. 36.—The European earwig, *Forficula auricularia* Linn. The males have the large curved forceps.

It also enters houses and may become a real nuisance. In the West the species has been found in Seattle, Washington, where it is reported injurious to roses and abundant in houses, and is a pest in the residential district of Portland, Oregon. In 1923 it was first discovered in Berkeley, California, and is just developing into a pest there. It also occurs in Vancouver, British Columbia.

It may be controlled by freely broadcasting, at nightfall, the poison bran mash as recommended for grasshoppers or by substituting a bait recommended by the Oregon Agricultural College composed of:

Sodium fluoride	12 ounces
Molasses	2 quarts
Wheat bran	12 pounds
Water	6 quarts

Dissolve the sodium fluoride in the water, stir in the molasses, add this mixture to the bran and mix thoroughly. If this is not enough liquid to wet all of the bran, a little more water can be added, but do not have it wet enough to drip without being pressed.

Great numbers may be trapped in flower pots or boxes filled with straw or newspapers and inverted on the ground.

The linear earwig, *Doru lineare* (Eschscholtz) (*Forficula linearis* Esch., *F. suturalis* Dohrn, *F. tæniata* Serville, *F. californica* Dohrn, *F. exilis* Scudd., *F. luteipes* Scudd.),[1] is a shining black or brown species 9–11 mm. long. It is usually found in rank grasses and is attracted to lights. It is recorded in California, Arizona, New Mexico (Texas, Mexico, Central America, South America).

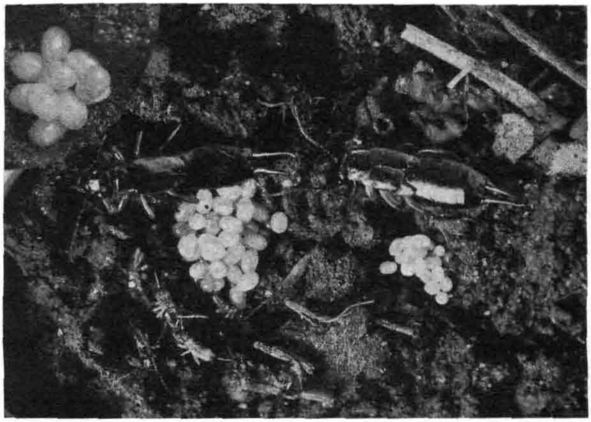

FIG. 37.—The European earwig, *Forficula auricularia* Linn. Females, eggs in nests, and newly-hatched young.

CHELISOCHIDÆ.

The black earwig, *Chelisoches morio* (Fabr.) (*Forficula*), is a large black species which is a native of the Philippine, Hawaiian, and other islands of the Pacific. It has been introduced into California and is recorded on peach trees near Menlo Park.[2]

LABIIDÆ.

The small earwig, *Labia minor* (Linn.) (*Forficula*), is a small species from 4 to 6 mm. long including the forceps. It is a cosmopolitan species which occurs about manure and flies at dusk. It is known to occur in Sonoma County, California (United States, Europe).

The chief earwig, *Prolabia arachidis* (Yersin) (*Forficula, Labia brunnea* Scudd.), is a small species scarcely over 10 mm. long with the wings not extending beyond the wing covers. It is a South American species taken aboard ship at San Francisco, California, but apparently not established ashore.

The toothed earwig, *Spongovostox apicedentatus* (Caudell) (*Spongophora brunneipennis* Scudder, *S. apicedentata* Caudell, *Labia melancholica* Rehn), occurs commonly in the dead parts of giant and other cacti, and among dead leaves in the desert regions of Arizona and Southern California (Texas).

[1] J. A. G. Rehn and M. Hebard, *Jour. N. Y. Ent. Soc.*, 22, 1914, p. 90.
[2] A. N. Caudell, *Proc. Ent. Soc. Wash.*, 8, 1906, p. 133.

LABIDURIDÆ

The maritime earwig, *Anisolabis maritima* (Géné) (*Forficula*),[1] is a dark mahogany brown species 12–25 mm. long, with pale legs and antennæ. The white cylindrical eggs, 2 mm. long, are laid in the soil in the fall of the year. The adults dig in the ground with their strong mandibles and crawl freely in water. It occurs under stones, logs, or other objects along the Pacific Coast of California. It also occurs in the States touching the Atlantic Ocean and Gulf of Mexico.

The spotted-legged earwig, *Euborellia annulipes* (Lucas) (*Forficelisa, Anisolabis, A. azteca* Caudell), is characterized by having one or two of the segments near the tip of the antennæ whitish and by the black bands on the femora. It is found under stones, logs, leaves, and debris of all kinds and may invade houses. This species occurs along the coast but is also found in the warmer interior regions of California, Arizona, New Mexico (Southern United States).

[1] C. B. Bennett, Description and Life History. *Psyche*, 11, 1904, p. 47.

CHAPTER VII

ORTHOPTERA (Order) [1]

(*Orthos*, straight; *pteron*, wing)

Straight-winged Insects

The members of this large order of terrestrial insects are somewhat difficult of brief characterization. They are variable in size, but for the most part fairly large; have simple metamorphosis; well developed biting and chewing mouth parts (Fig. 39); usually with two pairs of well developed wings, the fore pair leathery and well veined, the hind pair membranous with numerous veins and folding longitudinally; wings may be wholly absent or rudimentary; cerci usually present (Fig. 38).

Some modern writers divide the order into a number of distinct orders, but following the advice of A. N. Caudell and Morgan Hebard, the writer is treating the order as generally defined. The Handlirsch [2] orders are herein designated as suborders.

[1] "*Orthoptera*." *Biol. Cent. Americana*, 1, 1893–99; 2, 1900–09. Various authors. S. H. Scudder, "Cat. *Orthoptera* N. A." *Smithsonian Misc. Coll.*, 189, 1867. "Cat. of the Described *Orthoptera* of U. S. and Canada." *Proc. Davenport Acad. Nat. Sci.*, 8, 1899.

C. W. Woodworth, *Grasshoppers in California*. Bul. 142, Cal. Agr. Exp. Sta. 1902.

A. N. Caudell, "*Orthoptera* from Colorado, Arizona, New Mexico." *Proc. U. S. Nat. Mus.*, 27, p. 775, 1903. "Notes on Some *Orthoptera* from British Columbia." *Ent. News*, 15, p. 62, 1904. "*Orthoptera* from Southern Arizona." *Proc. U. S. Nat. Mus.*, 28, p. 477, 1905. "Notes on Some Western *Orthoptera*." *Proc. U. S. Nat. Mus.*, 34 p. 71, 1908.

C. P. Gillette, *List of Colorado Orthoptera*. Bul. 94, Tech. Ser. No. 6, Colo. Agr. Exp. Sta., p. 17, 1904.

James A. G. Rehn, "*Orthoptera* from Arizona, New Mexico and Colorado." *Proc. Acad. Nat. Sci. Philad.*, 56, p. 562, 1904. "*Orthoptera* from Western U. S." *Kansas Acad. Sci.*, 19, p, 221, 1905. "*Orthoptera* of Montana, Yellowstone Park, Utah and Colo." *Proc. Acad. Nat. Sci. Philad.*, 58, p. 358, 1906. "*Orthoptera* from Southern Arizona." *Proc Acad. Nat. Sci. Philad.*, 59, p. 24, 1907.

James A. G. Rehn and M. Hebard, "Orthopterous Insects of Southwestern U. S." *Proc. Acad. Nat. Sci. Philad.*, 58, p. 358, 1906; 60, p. 365, 1908; 61, pp. 111, 409, 1909.

C. F. Baker, "Pacific Slope *Orthoptera*." *Invertebrata Pacifica*, 1, p. 71, 1905.

E. M. Walker, "*Orthoptera* of the Canadian Northwest." *Can Ent.*, 38, p. 55, 1906.

W. F. Kirby, "Syn. Cat. of *Orthoptera*." *Brit. Mus. Nat. Hist.*, 1, 1904; 2, 1906; 3, 1910.

B. H. Walden, "*Euplexoptera* and *Orthoptera* of Connecticut." Bul. 16, *Conn. Geol. and Nat. Hist. Surv.*, 1911.

W. S. Blatchley, "*Orthoptera of Northeastern America*." Nature Pub. Co., Indianapolis, Ind., 1920. Complete bibliography.

Chr. Schröder, *Handbuch der Entomologie*, Jena, pp. 350–364, 1922; 443–502, 1923.

W. W. Henderson, *Œdipodinæ of Utah*. Tech. Bul. 191, Utah Agr. Exp. Sta., pp. 1–150, 1924.

A. N. Caudell has given the writer valuable assistance in this order.

[2] A. Handlirsch, Chr. Schröder, Handbuch der Entomologie, Jena, pp. 443–502, 1923.

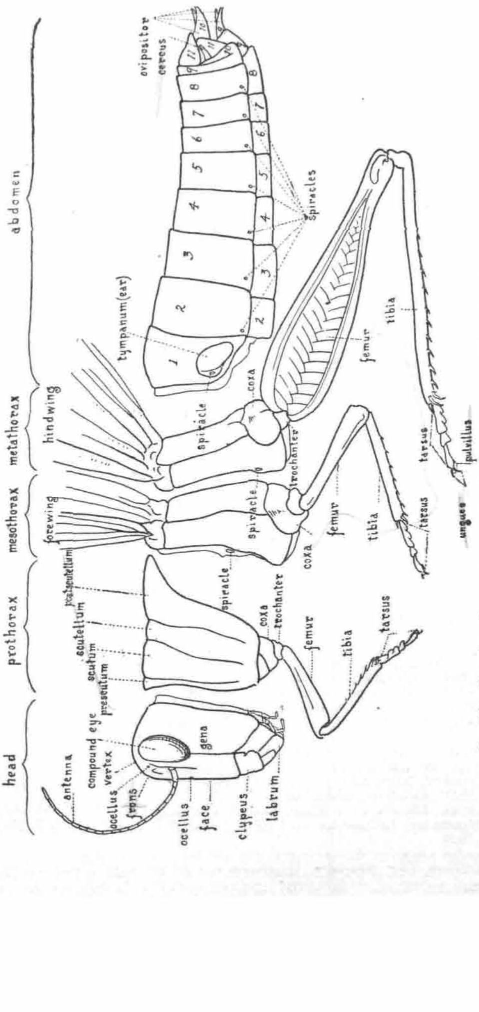

FIG. 38.—Drawing of a grasshopper, showing the chief parts of the external anatomy. (After Herms.)

KEY TO SUBORDERS

1. Hind femora normal, not greatly enlarged for jumping; stridulating organs absent 2
   Hind femora greatly enlarged for jumping; stridulating organs present. **Saltatoria**

2. Body elongate; head free; pronotum elongate; legs slender, rounded; cerci simple *or jointed; walking or crawling insects* 4
   Body oval, flattened; head partially or wholly concealed beneath pronotum; pronotum transverse, shield-like; legs flattened; cerci simple or jointed. 3

3. Cerci jointed; fast running and free living insects. . . . . **Blattariæ** p. 102
   Cerci simple, not jointed; ectoparasitic on small mammals (Tropical) (*Hemimerus*) . . . . **Diploglossata**

4. Fore legs normal; cerci simple, not jointed. . . . . **Phasmida** p. 106
   Fore legs enlarged for grasping living prey. . . . . **Mantodea** p. 109

SALTATORIA (Suborder)

Grasshoppers, Katydids, Crickets

This order consists of medium-sized to large insects with simple metamorphosis and strong, biting mouth parts. The shape is elongate; apterous

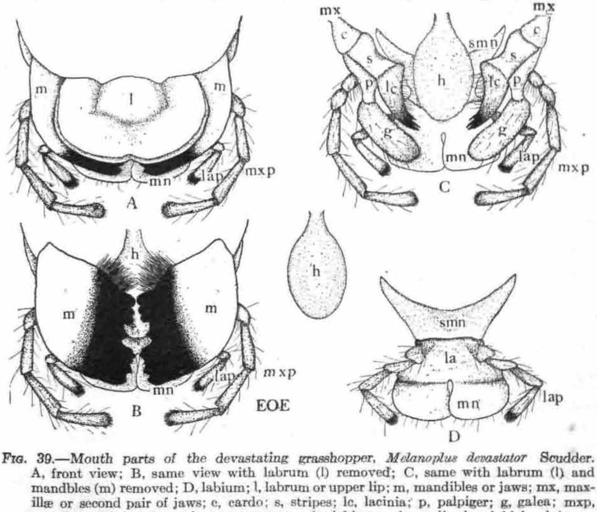

FIG. 39.—Mouth parts of the devastating grasshopper, *Melanoplus devastator* Scudder. A, front view; B, same view with labrum (l) removed; C, same with labrum (l) and mandbles (m) removed; D, labium; l, labrum or upper lip; m, mandibles or jaws; mx, maxillæ or second pair of jaws; c, cardo; s, stripes; lc, lacinia; p, palpiger; g, galea; mxp, maxillary palpi; h, hypopharynx or tongue; la, labium or lower lip; lap, labial palpi; mn, mentum; smn, submentum.

or winged, the wings consisting of a front pair of long, narrow, leathery tegmina and a hind pair of wide, thin, membranous wings which fold

fanlike; the hind legs are long with enlarged femora for jumping (Fig. 38). The members are, with a very few exceptions, plant feeders and among the most destructive pests known. They are diurnal and nocturnal, the latter often great singers during the summer nights. The order may be separated into four important families.

KEY TO FAMILIES

1. Tarsi five-jointed .... **Grylloblattidæ** p. 102
   Tarsi with less than five joints 2
2. Antennæ short and setiform, usually much shorter than the body 3
   Antennæ long and filiform, usually as long or longer than the body 4
3. Arolium or pad present between the claws; pronotum rarely extending over more than the base of the abdomen; tegmina or fore wings usually well developed. (Locusts, Grasshoppers) (*Acrididæ, Acridiidæ*) .... **Locustidæ** p. 71
   Arolium absent; pronotum extending over the abdomen; tegmina or fore wings vestigial. (Grouse Locusts) .... **Tetrigidæ**
4. Tarsi four-jointed. (Katydids) (*Locustidæ*) .... **Tettigoniidæ** p. 86
   Tarsi three jointed. (Crickets) .... **Gryllidæ** p. 98

TETRIGIDÆ [1] Grouse or Pigmy Locusts.

The members of this family are the smallest of the locusts and are easily recognized by the prolonged and tapering pronotum which extends backwards to or beyond the tip of the abdomen; by the presence or absence of rudimentary stub-like tegmina on the sides of the body covering only the bases of the wings; by the prolonged, chin-like pronotum which covers the mouth parts; and by the absence of the arolia between the claws.

These very interesting insects occur in many localities and match to a remarkable degree their immediate surroundings. According to J. L. Hancock the food consists of vegetable molds, decomposing humus in the soil, algæ, mosses, lichens, grasses, seeds, and other vegetable matter. The eggs are laid in the ground in spring and hatch in early summer, the winter being passed in the adult or immature rather than in the egg stage. Although they are often abundant in grassy places, on hillsides or along streams, none have been reported as pests in our region.

Very little systematic and life history work has been done on our western forms and but few of the many known are included in this paper.

Brunner's grouse locust, *Acrydium brunneri* (Bolivar) (*Tettix*), is broad, granulate, dark brownish-yellow often with two black spots on the pronotum, short wing stubs, and from 9 to 14.5 mm. long. It is a boreal species occurring in small clearings in coniferous forests in British Columbia, Washington, Oregon, Idaho, Montana, Wyoming, Colorado (Canada, U. S.)

[1] The name of this family has not long been established since it has usually been included in the *Acrididæ*. The names *Tettigidæ* and *Acrydiidæ* are also used for it. Comstock uses the subfamily *Acrydiinæ* for these insects.

J. L. Hancock, "Illinois Grouse Locusts." *Trans. Am. Ent. Soc.*, 1896, p. 235. The *Grouse Locusts of Minnesota*. Bul. 55, Minn. Agr. Exp. Sta. 1897, p. 105. "Syn. of Subfamilies and Genera N. A. *Tettigidæ*." *Psyche*, 9, 1900, p. 1. *The Tettigidæ of N. A.* Chicago, 1902. "*Tetriginæ*." *Gen. Insectorum. Fasc.*, 48, 1906.

A. P. Morse, "*Tettiginæ*." *Biol. Cent. Am. Orthoptera*, 2, 1900, p. 3.

M. Hebard, "Species Assigned to *Cavotettix*." *Ent. News*, 30, 1919, p. 78.

W. S. Blatchley, *Orthoptera Northeastern Am.* Nature Pub. Co., Indianapolis, Ind., 1920, p. 149.

The incurved grouse locust, *Acrydium incurvatum* (Hancock) (*Tettix incurvata* Hanc.), is a short species variable in color being light or dark fuscous, often with pale yellowish lateral stripes—one on each side of the pronotal disc—and occasionally with a pale, median, longitudinal band or a pale spot on the pronotum. It is reported from Washington, Colorado, and New Mexico, but probably has a much wider distribution in the West.

The toltecan grouse locust, *Paratettix toltecus* (Saussure), is a short, broad, yellowish-gray species 8 to 10 mm. long. It is a Mexican species ranging into New Mexico, Colorado, Arizona, California (U. S.). *P. cucullatus* Burmeister is recorded from Colorado and Kansas; *P. morsei* Hancock, from California; *P. robustus* Hancock, from Wyoming.

The primitive grouse locust, *Merotettix pristinus* Morse, is a very small, rugose, dark brown species 6 to 9 mm. long, often with a pale, broad band on the posterior of the pronotum. It occurs in Southern California.

The Aztec grouse locust, *Telmatettix aztecus* (Saussure), is slender, blackish or reddish, often with the lower lateral margins of the pronotum yellow. It varies considerably in size, from 5 to 12 mm. in length. It is a Mexican species ranging into Arizona and California.

The arid grouse locust, *Telmatettix aridus* Hancock, is a narrow, dark cinnamon red species 12 mm. long occurring in the desert regions of Southern California.

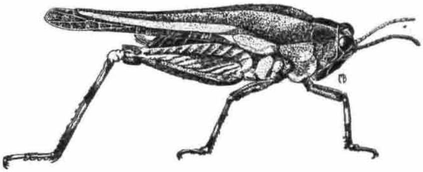

FIG. 40.—The western grouse locust, *Telmatettix hesperus* Morse.

The western grouse locust, *Telmatettix hesperus* Morse (Fig. 40), is slender, rufous, gray or black, frequently with the lower margins of the pronotum and the hind femora pale. The length of the female averages about 15 mm. It occurs in Oregon and California.

LOCUSTIDÆ.[1] (*Acrididæ, Acridiidæ*). Locusts, Grasshoppers (Figs. 38, 39).

The grasshoppers, short-horned grasshoppers, or locusts comprise a large family of very destructive insects which have concerned the welfare of the human race since the very earliest times. The members are of all sizes from the small migrating forms to the very large lubber grasshoppers which are unable to fly at all. They are characterized by having short filiform or clubbed antennæ; greatly enlarged hind femora for jumping; three-jointed tarsi with an arolium or pad between the claws; very short, inconspicuous ovipositor consisting of four short, horny pieces

[1] C. H. T. Townsend, "Notes on *Acridiidæ* of New Mexico and Arizona." *Insect Life*, 6, 1893, p. 29.
S. H. Scudder, "Rev. of the Group *Melanopli*." *Proc. U. S. Nat. Mus.*, 20, 1898, pp. 1–421.
M. Hebard, "New Genera and Species of *Melanopli* in U. S." *Trans. Am. Ent. Soc.*, 44, 1918, p. 141; 45, 1919, p. 257; 46, 1920, p. 225.
J. A. G. Rehn and M. Hebard, "Study of N. A. *Eumastacinæ*." *Trans. Am. Ent. Soc.*, 44, 1918, p. 223.
J. A. G. Rehn, "N. A. *Œdipodinæ*." *Trans. Am. Ent. Soc.*, 45, 1919, p. 229.
W. S. Blatchley, *Orthoptera of Northeastern America*. Nature Pub. Co., Indianapolis, Ind., 1920, p. 187.

called valves; a pair of narrow tegmina and a pair of strong membranous fanlike wings. The tegmina and wings are often rudimentary and sometimes entirely absent. Grasshoppers occur throughout the world and are known in practically every locality. The life history is very much the same in all species. In the fall white elongated eggs are laid in a hole in the ground in a matrix of glutinous fluid which hardens and binds them together, thus forming a mass somewhat bean-shaped and protected from moisture during the winter which follows. From a few to 30 or 60 are laid in regular order in each hole. The eggs hatch in the spring of the year in March, April, or May and the young nymphs, which appear much like the adults without wings, begin to feed at once on the green plants. After five molts maturity is reached in midsummer or fall. Not all grasshoppers pass the winter in the egg-stage. A number of species, especially in the Southwestern States, are to be found in the nymph or adult stage throughout the winter months, the nymphs reaching maturity in early spring and the adults laying eggs at that season. Grasshoppers are not continuous singers like the katydids and crickets, and are able to make noises during the daytime only. Some feebly stridulate when at rest by rubbing the hind femur against the lower edge of the tegmina, while the majority make their call during flight by rubbing together the front edges of the wings and the under surface of the tegmina producing a sharp, crackling sound; they may also call while at rest. The habits are quite variable. The great majority of species breed and live pretty much in the same general areas throughout the year and may be termed non-migratory locusts, while a lesser number of species which are small in size and countless in individuals often leave the breeding grounds when the wings are fully developed and migrate in vast swarms, short or long distances, settling in grainfields, orchards, and other cultivated areas and often devastating everything before them. These marauders are known as migratory locusts. They normally breed in the bare grassy foothills of the higher mountain ranges as the Rocky, Sierra, and Cascade Mountains, and leave the breeding grounds when the grass begins to dry up in the summer. Usually enough remain behind to carry the species from year to year. There is but one generation annually. Grasshoppers are omnivorous feeders on all kinds of green and dry vegetable matter and become cannibalistic and carnivorous when the vegetable diet is not available. Their depredations are so well known as to need little comment here, except to point out the fact that with the cultivation of the foothill breeding grounds the migratory locusts are gradually becoming a thing of the past. Those which breed in the meadows, alfalfa fields, and along the ditch banks and fences, are with us always and with proper conditions often become destructive to a marked degree.

Natural Enemies. There are many natural enemies of grasshoppers and altogether they play a very important part in the reduction and check of these pests.

Of the fungous diseases the most important one in the West is *Empusa grylli* Fres. which is common in the Rocky Mountain States, but which is effective only under rare circumstances.

The egg destroyers are the most effective and consist of the locust mite, *Eutrombidium trigonum* (Hermann) and other related mites; dip-

terous and hymenopterous egg parasites; the larvæ and adults of the predaceous carabid ground beetles; the larvæ of the soldier and meloid beetles; the larvæ of robber flies; and countless other predatory insects.

Many of the above are also predaceous on the nymphs and adult locusts, which are so extensively preyed upon by wasps, ground beetles, tiger beetles, robber flies, and so forth.

Among the true parasitic forms on the nymphs and adult grasshoppers may be included the hair worms (*Agamermis* spp. and *Mermis* spp.), hymenopterous parasites and tachinia, bombylid, and flesh flies. The flies develop as young on or within the body of the host, the eggs having been previously laid on the outside or inserted within the body of the locust.

CONTROL. The control of grasshoppers has always been an important part of the work of the entomologist and has received a great deal of attention with the result that efficient methods have been devised for all kinds of emergencies under every condition. Control measures may be listed under certain important headings.

Poison Baits. For general use there is nothing quite so good to kill grasshoppers on a large scale as the poison baits. The poison bran mash was originated and first used near Sacramento, California, in 1885. It consisted of a mixture of arsenic, sugar, middlings, and water. D. W. Coquillett later substituted bran for middlings.[1] The ingredients are rather expensive, but are easy and quick to prepare and admit of rapid distribution over large areas of infested territory. In mixing up these baits it is often necessary to make substitutions because of the difficulty in obtaining certain ingredients. For this reason, also, several types of baits are suggested.

The poison bran mash found most successful for general use is prepared as follows:

Bran or middlings	25 pounds
Blackstrap molasses	2 quarts
White arsenic, sodium arsenite, or Paris green	1 pound
Water to make a thin mash	3 to 4 gallons

Thoroughly mix the bran and poison while dry. Dilute the molasses in one or two gallons of water and add while stirring the poisoned bran, then add more water until a thin mash is secured. The addition of finely chopped oranges or lemons to the above will often make it more attractive and may succeed when the ordinary mash fails. The substitution of ¾ ounce amylacetate for the oranges and lemons is cheaper and gives nearly as good results, and is suggested wherever serious invasions threaten. Paris green has one advantage in that it colors the bran and gives an indication of proper mixing, but has no other advantage over white arsenic. Sodium arsenite is more readily soluble and is being largely substituted for white arsenic and Paris green. Arsenate of lead as used for spraying is not at all suitable for poison bait. Alfalfa meal is a splendid substitute for bran. In the absence of such materials sawdust or even finely cut bits of paper may be treated with the molasses, poison, and amylacetate with good effects. The paper when dried may be sown by hand and carried for miles over the plains by the wind.

[1] D. W. Coquillett, *Rept. of Entom.*, U. S. Dept. Agr., 1885, p. 290.

Poison baits may be sown broadcast by hand or preferably by a broadcast grain seeder—a small amount being placed in the hopper at a time by means of a paddle, rather than attempting to fill the hopper. This requires the constant efforts of one person to insure an even distribution. About five pounds of the mash are required for an acre of land. Applications may be made in advance of an invasion or in the infested areas under practically all conditions in waste lands, orchards, vineyards, gardens, pastures, alfalfa fields, and so on, without danger to crops or to grazing stock. In cases of advancing migrations the poison should be placed out just ahead of the grasshoppers in order to check them before the cultivated areas are attacked. Insects killed by the mash are often eaten by others and killed by the poison which thus works over again and again.

Hopper Dozer. The hopper dozer is almost a thing of the past having given way largely to the poison baits. In alfalfa fields and some other forage crops this implement may still serve a very good purpose. There are many methods of construction. Two common types are used: one with an oil pan at the bottom and the other with a cage in the rear of the front shield. In either case the back and sides may be made of thin sheet iron or of cloth. The pan containing the crude oil is made three or four inches deep, two or three feet wide, and as long as desired, usually eight or ten feet. The whole is mounted on sled runners and drawn by two horses, one at each end. The cage type is constructed with a front shield, a slot at the bottom leading into a large screened cage two or three feet square and the full length of the shield. It is more suitable for rough or hilly land and has an added advantage in that the captured grasshoppers may be sacked or dried and used for poultry food.

Cultivation. Plowing up the eggs in the breeding areas destroys all that are disturbed and is a thorough and reliable means of preventing invasions. This means of control may be practiced along the ditch banks, in pasture lands, or in the plains and foothills districts. The gradual reclaiming of the foothills and plains regions is partly responsible for the great reduction of grasshopper migrations and may eventually do away with them altogether.

Burning. Wherever possible, burning is a sure and quick means of destroying a grasshopper invasion where open dry grass is being traversed. It is so dangerous, however, that it can only rarely be undertaken.

Cyanide. Much success has recently been obtained in some of the Western States in killing the young grasshoppers before or when about half grown, with 50% calcium cyanide in the form of flakes, granules, or dusts when applied at the rate of about 200 pounds per acre. The application is best made with a good dusting machine or with a wheelbarrow seeder.

Turkeys. In past years it would seem folly to suggest turkeys as a possible means of grasshopper control, but at the present time thousands of turkeys are being herded in the favorite breeding grounds and the results are remarkable. In a great many instances flocks of turkeys have been shipped to infested cultivated areas and pasture lands with marked beneficial results. Many cattle raisers in the foothills have large flocks of these birds to prevent the large annual losses of feed ordinarily consumed by locusts.

KEY TO SUBFAMILIES

1. Prosternum without a tubercle between the front legs........................ 2
   Prosternum armed with a distinct conical or cylindrical tubercle between the front legs.. **Locustinæ** p. 78
2. Face more or less oblique, usually meeting the vertex at an acute angle; wings nearly uniformly transparent, never brightly colored or with a black band **Tryxalinæ**
   Face nearly or quite vertical and rounded at its junction with the vertex; wings usually bright colored and generally with a black band............ **Œdipodinæ**

TRYXALINÆ (Subfamily). Slant-faced Locusts. **The creosote locust,** *Bootettix argentatus* Bruner, is rich green variegated with brown, black, and silvery white. The young are pale green. All forms match the creosote bush on which they feed in New Mexico and Texas.

The green desert grasshopper, *Orphulella compta* Scudder, is a beautiful pale green species with brownish head and a brown or yellow stripe extending from the dorsolateral margin of the prothorax to the full length of the tegmina, broadening to include the entire tips. Some forms are pale leaf brown. The length is 16 to 22 mm. The writer has taken this species from alfalfa and barley fields and grasses in Imperial Valley, California. It also occurs in Arizona. Other western species are: the **spotted-winged locust,** *Orphulella pelidna* Burmeister, a common species throughout the United States, recorded in California and New Mexico; *O. affinis* Scudder in California; *O. decora* McNeill and *O. obliquata* Scudder in Colorado; *O. deserta* Scudder in Utah; **the salt locust,** *O. salina* Scudder in Colorado and Utah.

Elliott's or the big-head grasshopper, *Aulocara elliotti* Thomas (*A. cæruleipes* Scudd., *A. decens* Scudd., *A. strangulatum* Scudd.), has a wide range of colors, but is commonly reddish brown with dark spots on the tegmina. The length of the body varies from 21 mm. in the male to 27 mm. in the female. It is often a serious pest, destroying range grasses, garden and forage crops. It occurs from the Rocky Mountains to the Pacific Ocean and from Canada to Mexico, being in practically every Western State, and in British Columbia.

ŒDIPODINÆ (Subfamily). The Band Winged Locusts. The yellow and red-winged grasshoppers of the genus *Arphia* are often found in alfalfa and grain fields but are seldom serious pests. Some of our common forms are: *Arphia arcta* Scudder in Colorado (U. S.); *A. behrensi* Saussure in California, Nevada; *A. frigida* Scudder from Alaska to Montana; *A. hesperiphila* Rehn in Southern California; *A. luteola* Scudder in Utah, Colorado, New Mexico (Texas); *A. ovaticeps* Saussure in Colorado; *A. ramona* Rehn in California; *A. teporata* Scudder in the Rocky Mountain States of Utah, Colorado, and New Mexico; *A. pseudonietana* (Thomas) in Idaho, Utah, and other Rocky Mountain States.

The cut crest locust, *Encoptolophus subgracilis* Caudell, is reported as injurious to vegetables at Yuma, Arizona.[1] *E. costalis* Scudder infests alfalfa fields in New Mexico.[2]

The yellow-winged, pellucid or warrior grasshopper, *Camnula pellucida* (Scudder) (*Œdipoda*) (Fig. 41), is variable in color from light yellow to dark brown with large, well-defined black spots on the tegmina, and two yellowish lines along the angles of the tegmina which merge about one-third the distance from the base. The young nymphs are pale yellow or almost black with a pale, oblique stripe on each side of the thorax. It is a small species, the mature forms averaging scarcely more than one inch

[1] A. W. Morrill, *Ninth Ann. Rept.* Ariz. Comm. Agr. & Hort., 1917, p. 53.
[2] C. H. T. Townsend, *Insect Life*, 6, 1893, p. 31.

in length and is migratory in habits, breeding in great numbers in small areas in the foothills, alpine meadows, and at high altitudes, each female usually laying two masses of from 30 to 40 eggs each. According to E. D. Ball the egg-masses may be so abundant as to literally fill the ground.[1] Upon reaching maturity the adults often migrate to the lowlands, although they are most damaging in the valleys of the mountain regions. This species occurs throughout North America and in the western area is most serious as a pest in Utah, Wyoming, Montana, and Idaho. In Colorado it is the commonest species in elevated regions. In Eastern Washington and Oregon it often migrates into the grain fields and does great damage. In British Columbia it breeds in the open ranges and often migrates to trees and forests for food. In California, Nevada, Arizona, and New Mexico it is particularly destructive to grasses and grain in upland valleys and meadows. In all sections it feeds on the native grasses, grain, forage and garden crops, and often invades vineyards and orchards, although it is not so apt to do this as some other species.

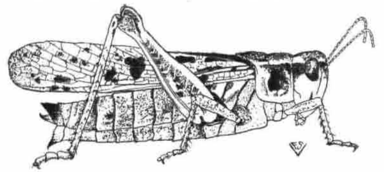

FIG. 41.—The yellow-winged or pellucid grasshopper, *Camnula pellucida* (Scudder).

Plowing up the small breeding areas in winter to destroy the eggs is very effective in controlling this particular grasshopper. The poison bait and other suggested measures are, however, also applicable to its destruction.

The coral-legged grasshopper, *Hippiscus corallipes* Haldeman, is sometimes injurious to cultivated crops in the Rocky Mountain Region, and *H. pardalinus* Saussure is a pest at times in California, Nevada, Utah, New Mexico, and has been reported as such in Montana.

The glaucous-winged grasshopper, *Leprus glaucipennis* Scudder, is from one to two inches long with color to match the ground on which it lives. The wings are a beautiful blue. This species inhabits the dry hills and pastures of Southern California and Arizona (Mexico).

The giant lubber grasshopper, *Agymnastus ingens* (Scudder) (*Leprus*) (Fig. 42), is a most interesting species of no economic importance. The males are 30 mm. long and are dark brown in color with bright orange wings bordered black. The hind femora are shining blue on the inside and the hind tibiæ are red. The females are robust, surface granulated, gray, brown, or dull red to match the color of the rocks and soil of the immediate vicinity. The tegmina and wings are shorter than the body, the wings being orange and black as in the male, but are of no use in flying. The length averages from 35 to 45 mm. They live in the grass among the rocks near the tops of the higher peaks in the Coast Range Mountains of Central California, having been taken only from Mt. Tamalpais and Mt. Hamilton, but they undoubtedly occur elsewhere at similar elevations. So completely do the females match their surroundings that they are rarely taken unless they are forced to move, which they do with great reluctance. They are most easily found by carefully looking in the places where the very active males hop out from the dry grass among the rocks, during the mating season in the latter part of May and in June.

The Carolina or black-winged locust, *Dissosteira carolina* (Linn.) (*Gryllus*), varies from light grayish yellow to various shades of reddish brown usually sprinkled with

[1] Bul. No. 138, Utah Agr. Exp. Sta. Feb. 1915.

many small, dark spots and resembling to a remarkable degree the dusty vegetation which it frequents. The wings are black with a yellow border. It occurs throughout the country and is most numerous during the late summer and fall along the roadsides and bare ground. It has been recorded from every State in the west and is not a pest of consequence. It is a strong flier and able to go considerable distances with more ease than most locusts display.

The long-winged locust, *Dissosteira longipennis* (Thomas) (*Œdipoda nebrascensis* Bruner),[1] is testaceous; the tegmina long, spotted brown; the wings blue at the base, becoming gradually black towards the disk. The length of the body is 29 mm. for the male and 43 mm. for the female. It is gregarious and migratory, in some places travel-

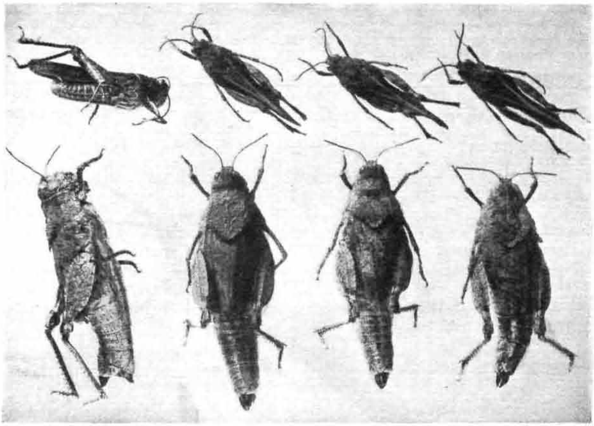

FIG. 42.—The giant lubber grasshopper, *Agymnastus ingens* (Scudder). Males at top, females at bottom.

ing 15 to 20 miles. The high ranges and prairies of 3,500 to 6,000 feet altitude are the chief habitats and the grasses the principal food, often being completely destroyed. It seldom attacks cultivated crops although it may feed on millet, sorghum, corn, grain, and vegetables. The adults are attracted to lights at night. The species ranges throughout the west having been reported in Colorado, New Mexico, Wyoming, Montana, and Idaho. *Sarcophaga kellyi* Aldrich lays its eggs on the pronotum of the freshly molted nymphs and is a common parasite. The sphegid wasp, *Chlorion atratum* (Lep.), stores great numbers of this locust in its nests, which are in turn invaded by the bembecid wasp, *Megastizus unicinctus* Say, which digs up the nests of the former, crushes the eggs, and lays its eggs on the buried grasshoppers, thus reducing the efficiency of the predator.

The pale-winged locust, *Dissosteira spurcata* Saussure (*Œdipoda obliterata* Thomas), is pale dusty yellow with faint spots. It is at times destructive to range grasses, alfalfa, and cultivated crops in Utah, Idaho, Oregon, Nevada, and California.

The red-wing locust, *Dissosteira venusta* (Stål) is a medium-sized, brown mottled species with bright red wings. It is common in California.

[1] H. E. Smith, Bul. 293, *Prof. Paper*, U. S. Dept. Agr., Oct. 7, 1915.

The Utah locust, *Spharagemon collare* (Scudder) (*Dissosteira utahensis* Thomas), is a beautiful, large brown species from 30 to 35 mm. long, with dark markings, red hind tibiæ and yellow wings with a black arc near the middle, and dusky, transparent tips. It occurs in northern North America as far west as to include the Great Basin and as far south as Texas.

Behren's grasshopper, *Conozoa behrensi* Saussure, feeds on barley but prefers Bermuda grass in California and Arizona.

The blue-winged locust, *Trimerotropis cyanipennis* Bruner, is a common species throughout the west ranging in California, Nevada, Colorado, Utah, Arizona, and New Mexico. It is not an injurious form. *T. tessellata* McNeill is common in California, Nevada, and Arizona. *T. vinculata* Scudder is common in dry areas and often injurious, but is not abundant enough to be serious. It is known in British Columbia, Washington, Oregon, California, Arizona, New Mexico (Texas, Mexico).

The large lubber grasshopper, *Brachystola magna* (Scudder) (*Brachypeplus*), ranges east of the Rocky Mountains and in the Great Basin. It is injurious and common from Montana to New Mexico.

LOCUSTINÆ [1] (Subfamily). The Spine-breasted Locusts.

The slender Mexican grasshopper, *Leptysma mexicana* (Saussure) (*Opomala, Arnilia*) (Fig. 43), is a slender, sub-cylindrical species with a slanting face, antennæ largest

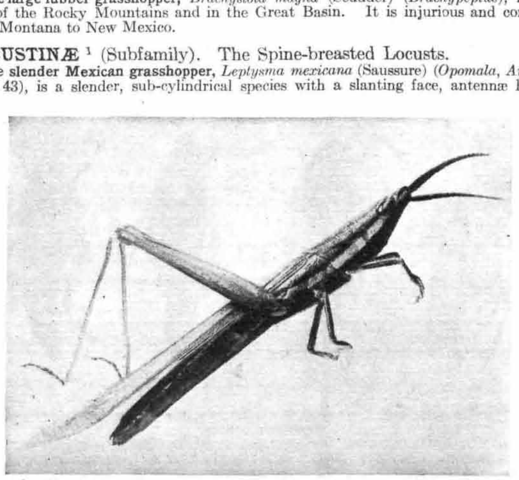

FIG. 43.—The slender Mexican grasshopper, *Leptysma mexicana* (Saussure). Female.

at the base and tapering to a point, brown color with a lateral pale stripe on each side. The length is about 30 mm. This species occurs in small numbers in various parts of California, particularly in the San Joaquin Valley.

The gray lubber grasshopper, *Dracotettix plutonis* Brun. var. *californicus* Bruner (Fig. 44), is a fine large, gray species with very short wings in both sexes. The females measure from 30 to 40 mm. in length; the males are much smaller measuring about half the length of the females. This very interesting species is of the color of the gray leaves of the wild buckwheat, *Erigeron*, on which it is found on the higher peaks of Mt. Hamilton and Mt. Tamalpais of the Coast Range Mountains, California.

The leather-colored locust, *Schistocerca alutacea* (Harris) (*Acridium emarginata* Uhler), varies from purplish brown to dark olive green in color and from 23 to 50 mm. in the length of the body. It is often troublesome to cultivated crops in the southwest where it occurs from Southern California to Texas and as far north as Colorado.

[1] The *Acridiinae* of older works.

The large green bush grasshopper, *Schistocerca shoshone* (Thomas) (*Acridium*), is a large green species with a typical median yellow stripe on the pronotum and from 40 to 65 mm. long to the tips of the folded wings.

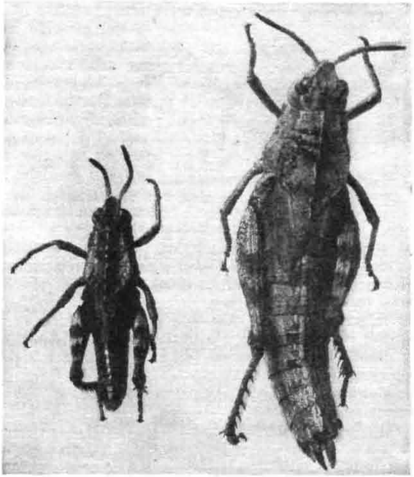

FIG. 44.—The gray lubber grasshopper, *Dracotettix plutonis* Bruner var. *californicus* Bruner. Male left, female right.

It inhabits the regions west of the Rocky Mountains and is most abundant and injurious in the Southwestern States. It is known to occur in Idaho, Utah, Colorado, New Mexico, Arizona, Nevada, California (Mexico). Because of its large size and great numbers it is often capable of doing serious damage. It normally feeds on cottonwood, poplar, willow, mesquite, cat-tail, grasses, and other native plants, but also attacks alfalfa, beets, cotton, corn, deciduous and citrus fruit trees, and many other crops.

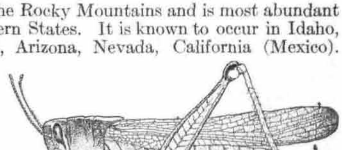

FIG. 45.—The green valley grasshopper, *Schistocerca venusta* Scudder. Female.

The green valley grasshopper, *Schistocerca venusta* Scudder (Fig. 45), is probably a form of *S. shoshone* Thomas according to Gaudell and Rehn, which it resembles in size, habits, and general color, also having a wide yellow, longitudinal stripe on the dorsum. It is recorded from Oregon, California, Arizona, and Utah.

The vagrant grasshopper, *Schistocerca vaga* (Scudder) (*Acridium vagum* Scudd.) (Fig. 46), is a large brown species with numerous black markings and glaucous spots on all the femora. It measures from 60 to 70 mm. to the tips of the folded wings. It occurs in Southern California, Arizona, and Mexico, and is commonly found on willow, but like other members of the genus it frequently attacks cultivated crops, including alfalfa, cotton, and citrus. It is the common grasshopper found in the orange and lemon orchards of Southern California. This species is often attracted to lights at night. *S. carinata* Scudder is close to *S. vaga* (Scudd.), but has the less maculate elytra and no red on the hind tibiæ. It is recorded from Arizona and Mexico.

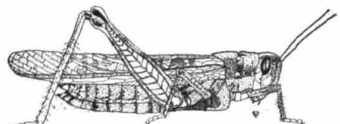

FIG. 46.—The vagrant grasshopper, *Schistocerca vaga* (Scudder). Female.

The large genus *Melanoplus* [1] includes the most destructive locusts. There are a great many species of rather small, but very numerous locusts some of which are migratory and do great damage. Only the more important species can be included here.

The lesser migratory locust, *Melanoplus atlanis* (Riley) (*Caloptenus*) (Fig. 47), is dull brown to dark olive green with a distinct row of black spots in the middle of the tegmina, dark bar on each side of the prothorax broken near the middle, red, yellow or blue hind tibiæ; tegmina longer than the body; the length is from 25 to 27 mm. As the common name implies, it is migratory, breeding in the open or partially wooded hills or in the plains and prairies, although it also breeds in alfalfa fields and pastures. It is one of the common injurious locusts and frequently a severe pest to grasses, forage, truck and grain crops, fruit trees, vines, and so forth. It is generally distributed throughout North America, occurring in every section of the west, and has often been mistaken for *Melanoplus spretus* (Riley) which it very much resembles. *M. affinis* Brun. is closely related to and also often confused with this species. It has a similar western distribution and is sometimes a serious pest.

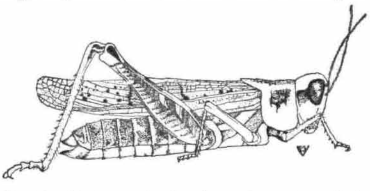

FIG. 47.—The lesser migratory locust, *Melanoplus atlanis* (Riley). Female.

The pale-spotted locust, *Melanoplus bilituratus* Walker (*Caloptenus*), is gray fuscous and much like *M. atlanis* (Riley) in appearance and size. It is at times destructive to alfalfa in Southern California. It has a wide distribution in the west from Montana to British Columbia and south to Mexico.

[1] S. H. Scudder, "A Revision of the *Melanopli*." *Proc. U. S. Nat. Mus.*, 20, 1898, pp. 1–421.

The arid locust, *Melanoplus aridus* (Scudder) (*Pezotettix*), is brownish fulvous marked with black, 17 to 21 mm. long, common on native grasses in California, Arizona, and New Mexico.

The two-striped locust, *Melanoplus bivittatus* (Say), varies considerably in color from reddish or brownish black to dark olive green with a yellow stripe on each side of the pronotum extending to the tips of the tegmina. The tegmina may be shorter than the abdomen. The males are often quite small, 22 mm. long, while the females vary from 25 to 37 mm. in length. This species prefers rank vegetation along streams and in meadows, but often becomes a serious pest to alfalfa, grain, vegetables, fruit trees, and cultivated crops generally. It is widely distributed in North America and occurs throughout the entire western region.

The northern locust, *Melanoplus borealis* Fieber, occurs in the sphagnum swamps of Alaska. It is also recorded elsewhere in Arctic America and Northern Europe.

Bruner's locust, *Melanoplus bruneri* Scudder (*M. alaskanus* Scudd., *M. extremus* Bruner), is a boreal species frequenting the low bushes in the river valleys of Alaska, British Columbia, Washington, Idaho, Montana, Colorado (U. S.).

The rusty locust, *Melanoplus cinereus* (Scudder), is cinereo-fuscus often with the dorsum of the head and the pronotum rust colored, and with distinct body markings. It feeds on green and dry plants, among which is artemisia. It ranges throughout the west from the Rocky Mountains to the Pacific Ocean and as far north as Idaho.

The devastating grasshopper, *Melanoplus devastator* Scudder (Figs. 48, 49), is a small, yellowish-brown species with a row of elongated black

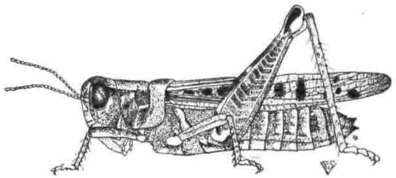

FIG. 48.—The devastating grasshopper, *Melanoplus devastator*, Scudder. Female.

spots along the middle of the tegmina, black markings on the pronotum and legs, hind tarsi blue at bases and yellow towards tips; 22 to 25 mm. in length. The variety *conspicuus* Scudder has the black markings more pronounced. As the common name implies, this is a devastating species and the most serious grasshopper pest in California. It regularly breeds in the grassy foothills of the Sierra Nevada and Coast Range Mountains and migrates into the Sacramento and San Joaquin Valleys where serious outbreaks have been known to occur periodically since 1822. The advance of agriculture in the foothills during the past twenty-five years, however, has greatly reduced the breeding grounds so that only small local migrations occur. As in the case of most of the migratory species, it devastates everything before it and has laid in ruins grasslands, grain, forage and truck crops, vines, orchards and the native trees, shrubs, flowers, and weeds. Although it is recorded in every State west of the Rocky Mountains, it has proven to be a pest only in California, Southern Oregon, Nevada, and Arizona.

The differential locust, *Melanoplus differentialis* (Thomas) (Fig. 50), is one of the most beautifully colored species, being yellowish or amber

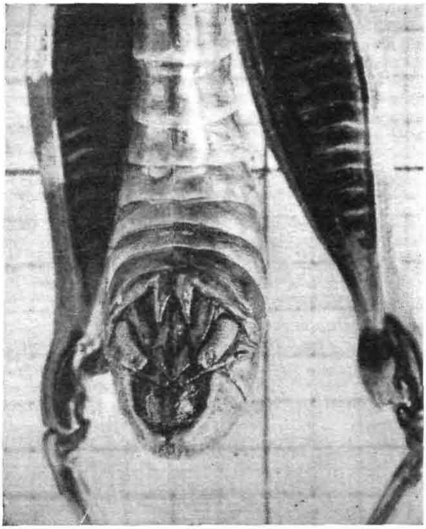

FIG. 49.—The devastating grasshopper, *Melanoplus devastator* Scudder. Posterior abdomen of the male. The background is composed of 1 mm. squares. (Photo furnished by W. C. Matthews.)

brown, with dark sutures, grayish tegmina, yellow femora marked with black, and yellow or bright red antennæ, hind tibiæ and tarsi. The surface is shining as if varnished. Some forms are quite dark and sober in color. The young are green or brownish with black markings. It is the largest member of the genus, varying from 40 to 50 mm. to the tips of the folded wings. It is not a true migratory species but breeds along the fences, ditch lands, in alfalfa fields and uncultivated areas where the entire life cycle may be passed. It prefers succulent rank vegetation and is a serious pest to alfalfa in the San Joaquin

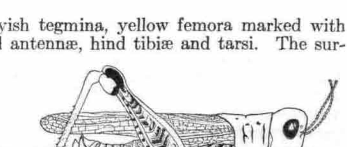

FIG. 50.—The differential grasshopper, *Melanoplus differentialis* (Thomas). Male.

Valley, California, and to cotton in Arizona and California. It feeds on various other field and garden crops and on deciduous fruit trees. The distribution is general throughout the United States and it has been reported in every Western State.

The dark-striped locust, *Melanoplus femoratus* (Burmeister), is dark to light brown with dark stripes. It is common on roadsides and has a wide distribution throughout North America. In the west it is most often found along the Pacific Coast from British Columbia to California, but is also recorded from Wyoming and Colorado.

The red-legged locust, *Melanoplus femur-rubrum* (De Geer) (Fig. 51), is dark brown or olive green with a row of small black specks on the tegmina and a continuous black bar on each side of the body beneath the wings, and the hind tibiæ and tarsi almost always red with black spines. It is a small, non-migratory species averaging 25 mm., and has the widest geographical distribution of any locust, occurring from the Arctic Circle to Central America. In the west it is most abundant and injurious in the Northern States and less so in the south. It frequents low places with rank vegetation avoiding arid localities, and feeds on many grasses, grains, field, forage and truck crops, vines, fruit trees, and native plants.

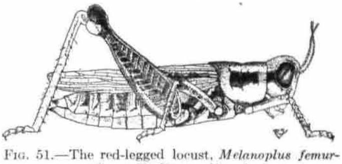

FIG. 51.—The red-legged locust, *Melanoplus femur-rubrum* (DeGeer). Female.

The detestable locust, *Melanoplus fœdus* Scudder, is dirty cinereous above and yellowish-brown beneath, from 24 to 30 mm. long. It is a mountain species occurring at or above 5,000 feet elevation in the Rocky Mountain States from Montana and Idaho to New Mexico. It is only occasionally destructive.

The herbaceous locust, *Melanoplus herbaceus* Bruner, is slender, pale green to dull olive brown in color, from 22 to 29 mm. long. It often occurs in immense numbers on native plants, shrubs, and trees in Arizona, New Mexico (Texas).

The marginate locust, *Melanoplus marginatus* (Scudder) (*Pezotettix*) (Fig. 52), is a small dark brown species less than 25 mm. long. The variety *amplus* Scudd. has the tegmina longer than the body, while the variety *pauper* Scudd. has the tegmina very short or abortive. The latter form is often mistaken for the nymphal-stage of other species. This species frequents the foothills, pastures, and alfalfa fields of California, and often invades cultivated fields, orchards, and vineyards in company with other grasshoppers.

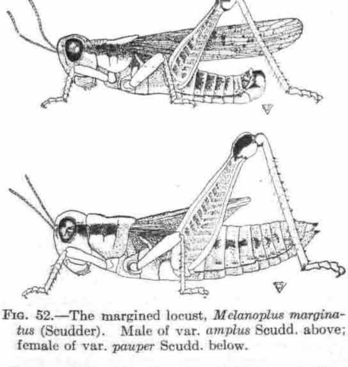

FIG. 52.—The margined locust, *Melanoplus marginatus* (Scudder). Male of var. *amplus* Scudd. above; female of var. *pauper* Scudd. below.

The western locust, *Melanoplus occidentalis* (Thomas), is a small reddish brown species 18 to 25 mm. long, mottled with black, the tegmina having a median broken yellow stripe. It inhabits the Rocky Mountain States from Montana to New Mexico and is at times abundant and destructive to field and forage crops in the latter State.

Packard's locust, *Melanoplus packardi* Scudder, is 26 to 28 mm. long, yellowish brown with posterior tibiæ red or blue. It occurs throughout the west and is at times abundant and injurious to pasture grasses.

The jumping locust, *Melanoplus saltator* Scudder, is occasionally injurious to grasses and clover in Oregon.

The Sonoma locust, *Melanoplus sonomensis* Caudell, is brownish with dark markings, the abdomen being reddish brown with a lateral black stripe along each side. In both sexes the tegmina are shorter than the pronotum. It is a very small species—the males being 13 and the females 15 mm. long—which feeds on the grasses of the dry hillsides along the coast of the San Francisco Bay Region, California.

The Rocky Mountain locust, *Melanoplus spretus* (Uhler) (*Caloptenus*),[1] is the most famous of all the destructive, migrating locusts of this country. It is various shades of brown with dark markings, and 29 to 35 mm. long to the tips of the tegmina. The posterior tibiæ are bright red. It breeds in the higher foothills region of the eastern slopes of the Rocky Mountains. In years past it migrated in incalculable numbers long distances for 300 or more miles into the cultivated areas of the States west of the Mississippi River, devastated great areas of wheat, corn, and other crops, and was especially serious in Nebraska, Kansas, Missouri, and Indian Territory. At the present time true migrations of this species are unknown and the old grasshopper days are almost forgotten except in some parts of the areas immediately adjacent to the breeding grounds of other species. This species was known to occur in practically all of the Western States between the Rocky Mountains on the east and the Sierra Nevada and Cascade Mountains on the west.

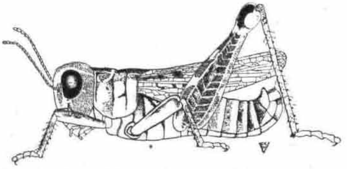

FIG. 53.—The valley grasshopper, *Œdaleonotus enigma* (Scudder). Male.

The Thomas locust, *Melanoplus thomasi* Scudder, is a Mexican species ranging into New Mexico and at times a serious pest to grapevines, fruit trees, and other cultivated crops.

The military grasshopper, *Pœcilotettix pantherinus* (Walker) (*Acridium, Caloptenus picticornis* Thomas), is yellow-amber with brown and black punctuation and black rings around the joints of the antennæ. The length varies from 19 mm. for the male to 28 mm. for the female. It breeds in the desert

[1] *First Rept.* U. S. Ent. Com. U. S. Dept. Agr. 1877; *Second Rept.* 1880; *Third Rept.* 1883.

According to W. W. Henderson of Utah, this species has often been confused with the lesser migratory locust, *Melanoplus atlanis* (Riley) and with the red-legged locust, *M. femur-rubrum* (De Geer) and may prove to be simply a form of either or both. At the present time *M. spretus* (Uhler) cannot be found in any of the Rocky Mountain States and it is doubtful if that species ever occurred in any true sense except as now represented by the two closely related species which may themselves prove to be identical. These two forms, however, still prove serious pests in many localities and are fully capable of taking the place of the once famous Rocky Mountain locust.

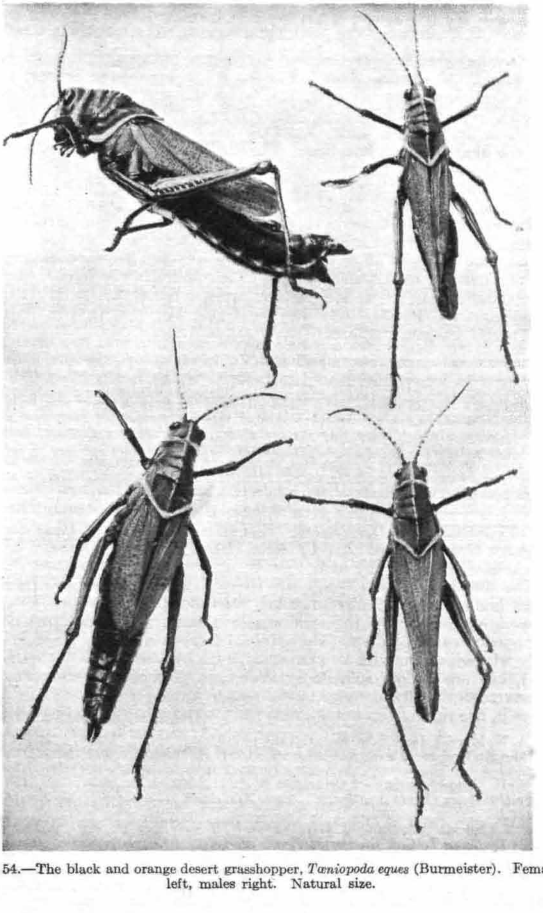

FIG. 54.—The black and orange desert grasshopper, *Tæniopoda eques* (Burmeister). Females left, males right. Natural size.

and normally feeds on mesquite but often overruns fields and pastures near the breeding grounds and is sometimes a pest to alfalfa, beans, and other cultivated crops in Arizona.[1] It climbs trees, fence posts, telephone poles, and other objects at night.

The valley grasshopper, *Œdaleonotus enigma* (Scudder) (*Pezotettix jucundus* Scudd., *Melanoplus collaris* Scudd., *M. flavoannulatus* Bruner, *Caloptenus flavolineata* Bruner) (Fig. 53), is, as the specific name implies, an enigma because of the different forms it assumes. The color is yellowish brown or amber with darker markings on the tegmina, legs, and body, and the hind tibiæ are pale blue. The tegmina may be abortive being but slightly longer than the pronotum, or again, fully half as long as the abdomen, and, rarely, longer than the abdomen. It breeds in dry grasslands and is migratory on foot, often appearing in destructive numbers and devouring everything in its path, particularly in some parts of California. It has been observed to invade orchards from dry fields and to devour the bark and all of the fruit of apricots and peaches, leaving only the pits hanging to the peeled twigs. Vines and other orchard trees, field, forage and garden crops, and pastures are also destroyed by it. It ranges throughout the Pacific Coast Region having been reported in Washington, Idaho, Oregon, California, Nevada, and Arizona.

The black and orange desert grasshopper, *Tæniopoda eques* (Burmeister) (*Rhomalea, T. picticornis* Caudell)[2] (Fig. 54), is a very large species 45–55 mm. long, shining black, conspicuously marked and lined with bright orange, the head and thorax with orange borders and a median orange line. The tegmina of the females are of various lengths, ranging from one-half to nearly the length of the abdomen, while those of the males are as long or slightly longer than the abdomen. The wings are geranium pink with black apical border. This species occurs in the dry deserts and mountains of Northern Mexico and in Texas, New Mexico, and Arizona, and often congregates in large numbers at the bases of mesquite and other vegetation. W. W. Jones observed it feeding in masses on its dead killed in the roads by automobiles in Arizona, September, 1924.

TETTIGONIIDÆ.[3] (*Locustidæ*). Katydids, Long-horned Grasshoppers, Meadow Grasshoppers, Cave Crickets, Camel Crickets, Jerusalem or Sand Crickets.

The members of this family are mostly large insects with slender, or stout bodies; long filiform antennæ; four-jointed tarsi; sword- or sickle-shaped ovipositors; and the ocelli usually absent. They vary considerably in appearance and habits. The arboreal forms are usually green in color, fully winged, and match to a remarkable degree the foliage on which they feed, but are seldom sufficiently abundant to become pests. They do, however, work some damage in the orange groves of California by eating holes in the rind of the small, green fruit. The grass-inhabiting forms are

[1] A. W. Morrill, *Jour. Econ. Ent.*, 6, 1913, p. 189.

[2] Morgan Hebard. *Tæniopodæ* as found in the U. S. *Trans. Am. Ent. Soc.*, 51, pp. 1–12, 1925.

[3] S. H. Scudder, "Cat. of *Orthoptera* N. A." *Smithsonian Misc. Coll.*, 189, 1868. "The *Orthoptera* Group *Scudderiæ*." *Proc. Am. Acad. Arts and Sci.*, 33, No. 15, 1898, p. 271.

A. N. Caudell, "*Decticinæ* of N. A." *Proc. U. S. Nat. Mus.*, 32, 1907, p. 285. "Subfamily *Decticinæ*." *Gen. Insectorum Fasc.*, 72, 1908. "*Rhaphidophorinæ* of Am. North of Mexico." *Proc. U. S. Nat. Mus.*, 49, 1916, p. 655.

James A. G. Rehn and M. Hebard, "Rev. of *Orthopterous* Group *Insaræ, Tettigoniidæ*." *Trans. Am. Ent. Soc.*, 40, 1914, p. 37. "N. A. *Tettigoniidæ*." *Trans. Am. Ent. Soc.*, 40 1914, pp. 271, 365; 41, 1915, pp. 11, 155; 42, 1916, p. 33; 46, 1920, p. 225.

often quite large, wingless, and may appear in such great numbers as to lay waste pasture lands and grain fields over large areas. The cave or camel crickets live in caves, cracks, or holes in the soil and may often occur among dry leaves or under rocks and boards. They are usually gray or brown in color, wingless, and often with the pronotum shield-shaped and are designated as shield crickets by some. Their food consists largely of decayed vegetable matter or the roots of tubers of plants. The Jerusalem or sand crickets are large, wingless inhabitors of the soil, being normally found under stones, logs, or other objects.

The eggs of the arboreal forms are elongate-oval, flat, white or brownish and laid overlapping end to end in rows on the leaves or twigs, or inserted in the edges of the leaves. Those of the grass and ground forms are laid in the soil or at the bases of plants. In all cases they are deposited in the fall and hatch the following spring, there being but a single brood each year. The eggs on the trees are very generally parasitized by small hymenopterous parasites which are probably responsible for the green katydids not being more numerous and destructive.

The males are among the most musical of the insects. The great majority sing at night, but a number of the arboreal forms stridulate during the day as well as during the night. The musical organs of many are located at the bases of the wings and consist of a small transparent area on each wing, those on the front wings or tegmina being crossed by a vein furnished with minute, file-like teeth on the upper side. The sound is produced by scraping this file across the upper side of the lower wing. Each species has a distinct call which serves as a means of allocation once the note is known. The auditory organ when present is a small tympanic membrane on the front tibiæ.

Control measures are usually applicable only for the gregarious ground-inhabiting forms which may become very destructive in the great plains country of the western slopes of the Rocky Mountains, in which cases the measures as recommended for the grasshoppers may be adopted.

This large family is well represented in the west with members too numerous to include here, so that only the more commonly known ones will be mentioned.

PHANEROPTERINÆ (Subfamily). Bush or Round-headed Katydids. **The angular-winged katydid,** *Microcentrum rhombifolium* (Saussure)[1] (Fig. 55), is the common species of this genus in the west. It is a large leaf-green species, the body from 25 to 30 mm. and the tegmina 42 to 47 mm. long. The "note may be represented by the syllable 'tic' repeated from eight to twenty times at the rate of about four to the second," and is made with the bases of the tegmina by both sexes. It is a true arboreal form, almost perfectly matches its green surroundings, is slow in movement and does not fly unless greatly disturbed. The eggs are dirty white to pale grayish brown in color, oval and flat, 25 x 5.5 mm., and are

[1] The species *M. laurifolium* (Linn.), previously listed under the above common name, does not occur in our region and all references to it are assignable to *M. rhombifolium* (Sauss.) or to *M. retinerve* (Burm.).

J. R. Horton and C. E. Pemberton, "Katydids Injurious to Oranges in California." Bul. No. 256. *Prof. Paper*, U. S. Dept. Agr., 1915.

glued so as to overlap, in single or double rows on twigs or leaves. They are deposited in the fall, September to November, and hatch the following spring, April and May. The nymphs are green and the back is distinctly humped or rounded. This species feeds on a variety of plants

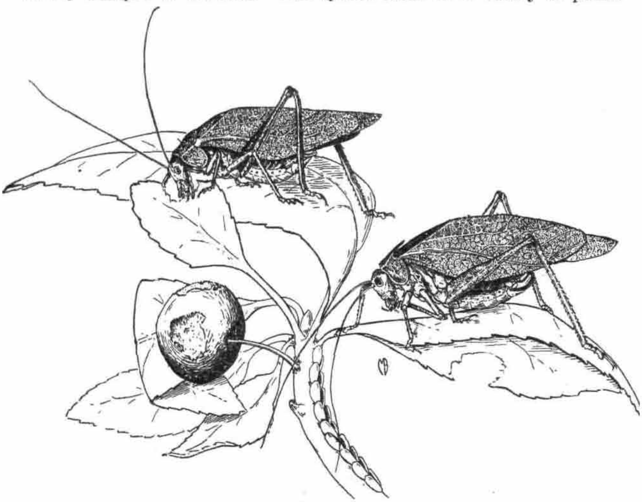

FIG. 55.—The angular-winged katydid, *Microcentrum rhombifolium* (Saussure). Male, female, eggs and characteristic injury to foliage and fruit of apple.

and is commonly found eating the leaves of orange trees in the San Joaquin Valley, California. The distribution extends throughout the United States.

The smaller angular-winged katydid, *Microcentrum retinerve* (Burmeister), has often been mistaken for *M. rhombifolium* (Sauss.) which it greatly resembles, but is smaller. It ranges chiefly in the southern part of the United States extending westward into New Mexico, Arizona, and Colorado, and perhaps as far west as the Sierra Nevada Mountains. It is reported as feeding on orange leaves in Arizona.

The fork-tailed bush katydid, *Scudderia furcata* Brunner [1] (Figs. 56, 57, 58), is the common western form of this genus, which is characterized by the narrow tegmina. The above species gets its name from the forked

[1] J. A. G. Rehn and M. Hebard have erected two varieties of the above as follows: *Scudderia furcata furcata* Brunner, which is northern in its distribution and *S. furcata furcifera* Scudder, which occurs in the southern part of our area. Some systematists believe these cannot be justly separated.
Trans. Am. Ent. Soc., 40, 1914, p. 297.

appendages at the tip of the abdomen. The color is dark green, and the length 30 to 38 mm. to the tips of the folded wings.

The eggs are much the same shape as those of the angular-winged katydid, being oval or somewhat reniform, very flat, 1.87 x 4.5 mm., pale gray,

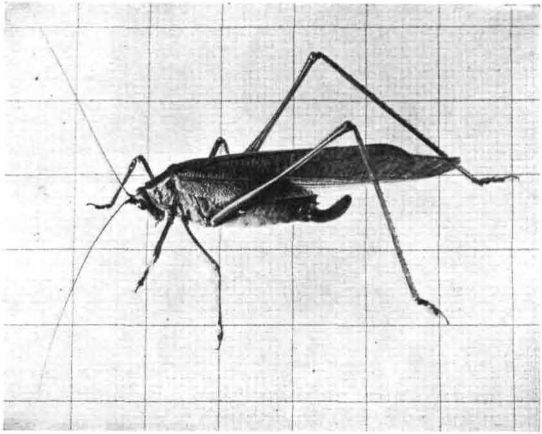

FIG. 56.—The fork-tailed bush katydid, *Scudderia furcata* Brunner. Female. Smallest squares in background are 1. mm. (Photo furnished by W. C. Matthews.)

smooth and shining. They are inserted in the edges of leaves of evergreen trees and shrubs, a really wonderful feat on the part of the female (Fig. 57). Eggs have been taken in the leaves of orange, olive and eucalyptus trees. They are laid in the fall and hatch in the spring, the adults appearing in June, July, and August. The nymphs and adults eat the young stems, leaves, flowers, and fruit of various trees and grapevines, and are at times destructive in orange groves due to their eating holes in the rind of small green oranges causing a considerable loss some seasons. This species occurs throughout the entire United States and is common in the west. During the summer days and nights at Berkeley, California, the writer has taken large numbers of the males by following the call which consists in a drawn-out ch-ch-ch-ch-eap! repeated at rather long intervals. While making the note the male appears restless and usually moves about on the supporting twig and flies freely and noiselessly when disturbed. It occurs in British Columbia, Washington, California, Oregon, Arizona, New Mexico, Nevada, Colorado, Idaho.

The Mexican katydid, *Scudderia mexicana* (Saussure) (*Phaneroptera*), is much like the preceding species but more slender. It occurs in Southern California, Arizona, New Mexico (Texas, Mexico, Lower California).

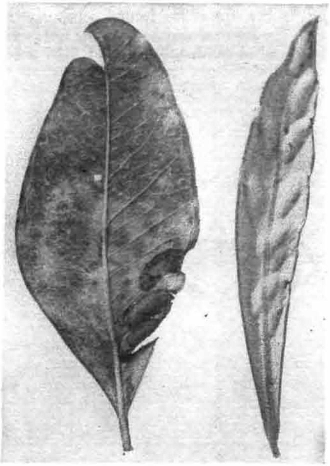

Fig. 57.—Eggs of the fork-tailed bush katydid, *Scudderia furcata* Brunner, inserted in the edges of the leaves of eucalyptus and olive.

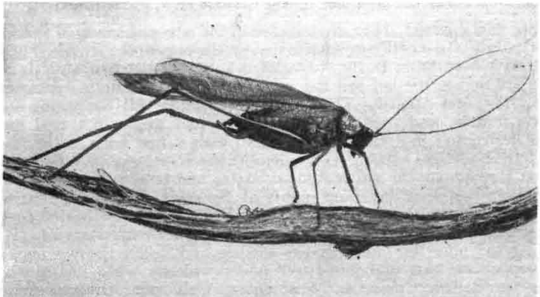

Fig. 58.—The fork-tailed bush katydid, *Scudderia furcata* Brunner. Male.

The pistillate katydid, *Scudderia pistillata* Brunner, has very broad, dull, leaf-like tegmina with heavy veinlets. It is distributed throughout the United States east of the Rocky Mountains, ranging west into Montana and Wyoming.

The Texan bush katydid, *Scudderia texensis* Saussure-Pictet, is a large, bright green species abundant in the eastern parts of the United States near marshes and bogs. It reaches its western limits in Montana and Wyoming.

The hoofed katydid, *Scudderia ungulata* Scudder, is a narrow-winged katydid about the size and general appearance of *S. frucata* Brunner, but is smaller, 21 to 23 mm. long, and has the end of the subgenital plate of the male hoof-shaped or V-shaped. According to W. W. Henderson it is the commonest species in Utah.

The cicada singing katydid, *Neoconocephalus triops* (Linn.), is a large very pale brown species, 50–60 mm. long. It is common in Southern California, especially in the Imperial Valley, where it may be taken in the shrubbery along the ditch banks at night, being easily found by following the shrill cicada-like song of the male. According to Caudell it ranges east into New Jersey.

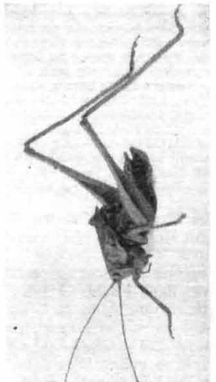
FIG. 59.—The carinated shield bearer, *Neduba carinata* Walker. Female left, male right. Natural size.

DECTICINÆ (Subfamily). The Shield Bearers. The members of this subfamily are known as shield bearers because of the prominent shield-like pronotum which is often produced over the base of the abdomen. The wings are normal in a few cases, but are mostly shorter than the abdomen or may be wanting entirely. The members of the species live singly or are gregarious, appearing in countless numbers and doing much damage to pasture lands in the great plains regions. The size is usually large and the color various shades of brown or gray to match the dead leaves and other herbage in which they live. Their food is chiefly vegetarian but they are commonly cannibalistic and predaceous.

The carinated shield bearer, *Neduba carinata* Walker (Fig. 59), is light brown with dark maculations, antennæ three times as long as the body, wingless, the body 19 to 22 mm. long, the ovipositor curved upwards, 13 to 17 mm. long. It lives singly in the coast hills or the open grasslands, in British Columbia, Washington, Oregon, California, Arizona, and New Mexico. The variety *picturata* (Scudder) is a colored form with the pronotum irregularly mottled. It occurs along the Pacific Coast from Northern California to Washington. The variety *convexa* Caudell is larger and paler than the species. It is commonly taken among the dry leaves or under rocks, stones, and other objects along the coast of Central California in the San Francisco Bay Region. It is also reported from Mount Shasta, California.

The small-winged katydid, *Cryptophyllicus chlorum* Hebard,[1] is of uniform bright grass green, with straw colored antennæ and pale brown eyes. The wings are short, the tegmina being slightly more than the length of the pronotum and two-thirds as long as the abdomen. The length of the body is slightly over 26 mm. It stridulates at night making a "loud and constant zick, zick, zick, zick." The only recorded locality is the Sierra Nevada Mountains in Mariposa County, California.

The sooty-brown shield bearer, *Capnobotes fuliginosus* (Thomas) (*Locusta*), is dark sooty-brown with lighter shades. The wings are longer than the body, from 50 to 68 mm. The ovipositor is shorter than the hind femora and curved downwards. The adults appear in July and August. The distribution includes Nevada, California, Arizona, New Mexico (Lower California).

Bruner's shield bearer, *Capnobotes bruneri* Scudder, is uniform wood brown, the elytra 47 mm. long, the ovipositor longer than the hind femora and curved downwards. It occurs in Southern California.

The western shield bearer, *Cynobotes occidentalis* (Thomas), is pale fawn colored, with the elytra and wings well developed and longer than the body in both sexes. It is reported in California, Nevada, Idaho, and Arizona. There are two green-color varieties, *viridis* Ckll. in New Mexico, and *uniformis* Caudell in Southern California.

The notable shield bearer, *Apote notabilis* Scudder, has wing stubs shorter than the pronotum; is brown marked with gray; and has the ovipositor narrower in the middle, curved downwards, longer than the hind femora, and unarmed at the sharp tip. It inhabits British Columbia, Washington, and Oregon.

The Mormon, Western, Great Plains, Idaho or black cricket, *Anabrus simplex* Haldeman [2] (*A. purpurascens* Uhler, *A. similis* Scudder, *A. coloradus* Thomas, *Acheta nigra* Lord), is the most destructive member of this family and one of the most destructive of the order. It is a large, wingless, pale yellow, dark brown or black, or green species with paler markings, the length varying from 35 to 45 mm. The ovipositor is curved upwards and slightly shorter or longer than the hind femora. The pronotum is greatly enlarged and extends backwards over the base of the abdomen. The eggs are first chocolate brown, but later turn gray, nearly straight 1.5 x 6 mm. They are laid loose in cracks or small holes in the hard, bare ground during the fall, each female depositing as many as a hundred eggs. Adobe or clay ground in the dry hills where vegetation is sparse is preferred for ovipositing. In copulating the large, white sperm sac of the male is caught by the vulva of the female and held until torn loose, failing which the male is dragged with it. The sac is carried for two or three hours. The Mormon cricket is diurnal, resting at night and active during the day. The male sings in the morning until about ten o'clock. It prefers succulent vegetation, but freely eats sagebrush, other bushes, is cannibalistic, and will eat dead animals. When abundant it is a serious pest to cultivated, forage and grain crops, pastures, and in fact everything.

The distribution embraces most of the area west of the Rocky Mountains, but it is not a pest in the extreme south and west. It has proven to be serious in Colorado, Utah, Idaho, Montana, Eastern Oregon, and Wyoming, but is also reported in Nevada and California.

When it is advancing, poison baits are often too slow, although if a double amount of white arsenic or Paris green is used, the baits are effective. Ditches, fences, rollers, gasoline torches, and such devices are preferable.

[1] *Ent. News*, 19, 1908, p. 158. Orig. desc.

[2] C. P. Gillette, *Ent. News*, 15, 1904, p. 321. Bul. 101, Colo. Agr. Exp. Sta., Apr., 1905.

S. A. Johnson, Bul. 52, Div. Ent. U. S. Dept. Agr., 1905, p. 62.

A. N. Caudell, *Proc. U. S. Nat. Mus.*, 32, 1907, p. 353.

Three varieties are listed: *coloradus* Thomas, which is usually grass green or varies from yellow to black, inhabiting British Columbia, Colorado, Utah, New Mexico; *maculatus* Caudell which is pale or dark brown, the abdomen mottled gray, occurs in British Columbia, Washington, New Mexico; *nigra* Caudell which is shining black and inhabits Oregon, Idaho, and Colorado.

The cerciated cricket, *Anabrus cerciata* Caudell, is brownish with obscure yellow mottlings, distinguished by its large size and the peculiar misshapen male cerci. It inhabits Washington and Oregon.

The long-legged cricket, *Anabrus longipes* Caudell, is a dark brown, long-legged form which inhabits open glades or small groves and clumps of trees in British Columbia and Washington.

The coulee cricket, *Peranabrus scabricollis* (Thomas) (*Thamnotrizon*)[1] is much like *A. simplex* Hald. in appearance and habits. The adults are large, fat, soft-bodied, 1½ inches long, dark reddish-brown with paler markings, completely apterous in the female, with short wing stubs in the male, and short legs. In the northwest the name coulee is applied to dry canyons which are often inhabited by this species. The coulee cricket breeds in the arid sage brush areas among the fallen leaves and in the grasses. The eggs are inserted singly at the bases of grass stems, each female laying about fifty. The young feed and remain in these areas during the first four instars after which, and about the first of June, they begin to move in great migratory hordes devastating everything in their path and often invading the cultivated areas and doing great damage to grain and other field crops. In moving they usually walk, but jump when disturbed. This species occurs in restricted areas of Montana, Idaho, and Eastern Washington.

The valley cricket, *Clinopleura melanopleura* (Scudder) (*Steiroxys*)[2] (Fig. 60), is a light or dark brown with yellow and fuscous markings, with very short abbreviated elytra, long legs, ovipositor straight and shorter than the hind femora; the length of the body is from 1¼ to 1½ inches, exclusive of the ovipositor. The life history of this species is probably not greatly different from the two preceding. It is sometimes sufficiently abundant in the San Joaquin Valley, California, to be destructive to pasturelands, grain, and alfalfa fields. It also occurs in Utah. A variety *infuscata* Caudell is smaller and darker than the typical species.

The yellow-margined valley cricket, *Clinopleura flavomarginata* Scudder, is much like the former but is testaceous and not so plainly marked. It has the same distribution.

The small valley cricket, *Clinopleura minuta* Caudell, is dark reddish with yellow margins on the pronotum. In other respects it resembles the other valley crickets except that it is the smallest species of the genus. It inhabits the western foothills of the Sierras, and the interior valleys and central coastal region of California.

The boreal grass katydid, *Stieroxys borealis* Scudder, is a brown species with short wing stubs occurring in British Columbia, Washington, Oregon, California, and Wyoming. In Eastern Oregon it is plentiful and sometimes harmful.

The pale grass katydid, *Stieroxys pallidipalpus* (Thomas) (*Decticus*), is yellowish to light brown, the hind femora darkly mottled. It is reported from Washington, Oregon, California, Idaho, Wyoming, Utah, and Nevada.

[1] *Ann. Rept.* U. S. Geol. Surv. Terr. 5, 1872, p. 441. Orig. desc.
R. E. Snodgrass, *Jour. N. Y. Ent. Soc.*, 13, 1905, p. 74.
A. N. Caudell, *Proc. U. S. Nat. Mus.*, 32, 1907, p. 363.
A. L. Melander and M. A. Yothers, Bul. 137, Wash. Agr. Exp. Sta., 1917.
[2] C. W. Woodworth, Bul. 142, Cal. Agr. Exp. Sta., 1902, p. 15.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed., 1915, p. 33.

The three-lined grass katydid, *Stieroxys trilineata* (Thomas) (*Thamnotrizon*), is a yellowish or dark brown species sometimes with three broken black lines on the dorsum. It is known in Montana, Idaho, Wyoming, Colorado, and New Mexico.

The short-tailed katydid, *Eremopedes brevicauda* Caudell, is a beautiful wingless, green and brown species with darker markings. The average length of the mature forms is from 10 to 15 mm. exclusive of the short ovipostor. It inhabits the rank grasses in damp meadows along the coast of Central California.

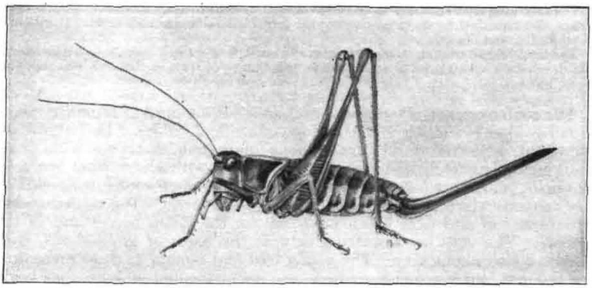

FIG. 60.—The valley cricket, *Clinopleura melanopleura* (Scudder). Female. (After Woodworth.)

RHAPHIDOPHORINÆ (Subfamily). Cave and Camel Crickets. The members of this subfamily are of medium to large size, wingless, hind tibiæ often very long and armed with spines, and are mostly of various shades of light and dark brown. The members are nocturnal and live in caves, wells, cracks or holes in the ground, in rotten logs, stumps or under damp leaves, stones, or other objects on the surface of the ground.

The yellow camel cricket, *Tropidischia xanthostoma* Scudder (*Rhaphidophora*),[1] is a very large grayish-brown species 1½ inches long and with the antennæ much longer than the body. The specimen taken by the writer occurred among the dead leaves on a creek bank in the redwood belt near Dyerville, Humboldt County, California, and was determined by A. N. Caudell. This rather rare and interesting species is reported in British Columbia, Washington, Oregon, and California.

The greenhouse stone cricket, *Diestrammena japanica* Blatchley,[2] is pale brownish mottled with darker spots. This interesting species has been introduced from Japan into many parts of the United States where it appears to breed normally in greenhouses and to attack various plants. T. D. A. Cockerell reports it as being abundant in a greenhouse in Colorado.[3]

The tree camel cricket, *Gammarotettix bilobatus* (Thomas) (*Ceuthophilus*), is a rather small brown species partially covered with black markings, with a short ovipostor curved upwards and armed at the tip with a number of teeth. The length is 10 to 15 mm. exclusive of the ovipositor which is about 3 mm. Unlike most of the members of this subfamily which live in the soil, the tree camel cricket is arboreal feeding on the leaves of the small oak trees and brush. The writer has taken it in large numbers in the western

[1] *Proc. Bost. Soc. Nat. Hist.*, 8, 1861, p. 12. Orig. desc.

[2] Hitherto known as *D. marmorata* (De Haän) and was renamed by W. S. Blatchley, *Orthoptera of Northeastern America*. Nature Pub. Co., Indianapolis, Ind., 1920, p. 611.

[3] *Jour. Econ. Ent.*, 2, 1909, p. 79.

foothills of the Sierras and in the Coast Range Mountains in Northern and Central California. It probably ranges into Oregon.

The genital camel cricket, *Gammarotettix genitalis* Caudell, is much like the former species, but without as many dark markings. It occurs in Southern California.

The California camel cricket, *Ceuthophilus californianus* Scudder (Fig. 61), is of a uniform pale brown color with darker chestnut-brown dorsal bands. The short ovipositor of the female is armed at the tip with six or seven spines. The size varies from

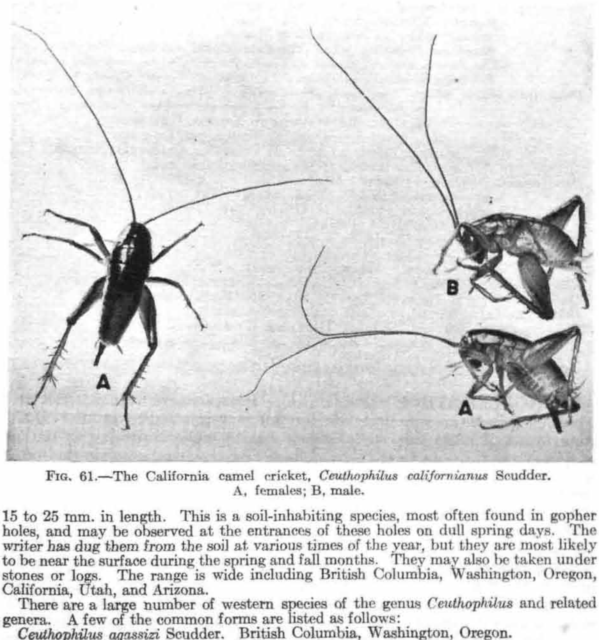

FIG. 61.—The California camel cricket, *Ceuthophilus californianus* Scudder. A, females; B, male.

15 to 25 mm. in length. This is a soil-inhabiting species, most often found in gopher holes, and may be observed at the entrances of these holes on dull spring days. The writer has dug them from the soil at various times of the year, but they are most likely to be near the surface during the spring and fall months. They may also be taken under stones or logs. The range is wide including British Columbia, Washington, Oregon, California, Utah, and Arizona.

There are a large number of western species of the genus *Ceuthophilus* and related genera. A few of the common forms are listed as follows:

Ceuthophilus agassizi Scudder. British Columbia, Washington, Oregon.
alpinus Scudder. Colorado.
aridus Bruner. Colorado.
arizonensis Scudder. Utah, Arizona, New Mexico.
genitalis Caudell. New Mexico.
henshawi Scudder. British Columbia, Washington, Oregon, California.
lamellipes Rehn. Arizona.
maculatus (Harris). **The spotted camel cricket.** Reported by C. H. T. Townsend as eating clothes on the lines at altitudes of 7,000 to 10,000 feet, New Mexico.[1]

[1] *Insect Life*, 6, 1893, p. 58.

neomexicanus Scudder. New Mexico (Kansas).
pallidus Thomas. **The wingless stone cricket.** Reported by C. H. T. Townsend as eating holes in lace curtains and other fabrics in New Mexico.[1] It also occurs in Colorado.
papucispinosus Rehn. Arizona, New Mexico.
polluticornis Scudder. Yosemite Valley, California.
testaceus Scudder. Wyoming, California (U. S.).
uniformis Scudder. On plains of Colorado, New Mexico (Kansas, Nebraska).
utahensis Thomas. Utah.
valgus Scudder. Colorado, New Mexico.
vinculatus Scudder. **The vinculate camel cricket.** Common pale brown species inhabiting much of the western area and reported from Washington, Montana, California, Nevada, Colorado, (U. S.).
Pristoceuthophilus celatus (Scudder) (*Ceuthophilus*). Has a horn-like projection on the vertex of the head just above base of antennæ. British Columbia, Washington, Oregon, California.
cercalis Caudell. Montana, Washington, Oregon.
pacificus (Thomas). British Columbia, California, Nevada.
salebrosus (Scudder). Washington, California.
Phrixocnemis franciscanus Rehn. Arizona.
longispinosus Caudell. Washington.
neomexicanus (Scudder). Arizona, New Mexico.
obesus Caudell. California.
oregonensis Caudell. Oregon.
validus Scudder. California.
vierecki Rehn. Arizona, New Mexico.
Rhachocnemis hostiferus Rehn. (*Phrixocnemis truculentus* Scudd.). Colorado.
Daihinia brevipes Haldeman. New Mexico, Colorado, Wyoming (U. S.).
Udeopsylla devius (Scudder) (*Ceuthophilus*). Colorado.
nigra Scudder. Arizona, California (U. S.).
robusta Haldeman. Colorado, California (Kansas, Mexico).
serrata Rehn. Arizona.
socorrensis (Rehn) (*Phrixocnemis*). New Mexico.

STENOPELMATINÆ (Subfamily). Jerusalem or Sand Crickets.[2] The members of this subfamily are very interesting wingless, ground-inhabiting forms of large size, smooth and shining amber brown with darker stripes across the dorsum of the abdomen, and nearly all occur in the states west of the Rocky Mountains. They live in the soil, remaining hidden during the day and coming out freely at night in search of food which consists of the roots and tubers of plants and of dead animal matter. The greatest numbers appear in the early spring when mating occurs. The white sperm sac of the male is clasped and torn off by the vulva of the female and carried for several hours as in the case of some of the shield bearers. It has been noted that the female frequently kills and devours the male after mating. The eggs are oval white with roughened surface and are laid in small masses in nest-like holes in the soil during the spring months (Fig. 63). The adults may be found during the summer under stones, logs, and so forth, during the day, and in the paths and roads at night or in the early morning. In dusty roads the queer tracks made by the feet on each side of the body which is dragged to make a smooth trail like that of snake, may often aid in their capture. The large, almost human-like head

[1] *Insect Life*, 5, 1893, p. 282.
[2] S. H. Scudder, "*Stenopelmatinæ* of Pacific Coast." *Can. Ent.*, 31, 1899, p. 113, Morgan Hebard, "Key to Species of *Stenopelmatus*." *Jour. N. Y. Ent. Soc.*, 24. 1916, p. 70.

of these crickets has caused them to be an object of fear and superstition. In the southwest where they are most abundant they are known by the Mexicans as "niña de la tierra" or "child of the earth" or as the child of the desert. C. D. Duncan [1] has noted that they stridulate by rubbing the inner surface of the hind femora against short spines on the sides of the abdomen, producing a sound resembling the rubbing together of pieces of sandpaper. There is little of economic importance attached to the

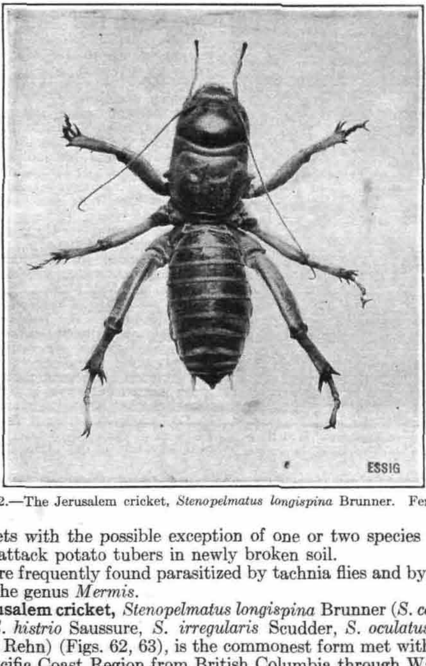

FIG. 62.—The Jerusalem cricket, *Stenopelmatus longispina* Brunner. Female.

sand crickets with the possible exception of one or two species which occasionally attack potato tubers in newly broken soil.

Adults are frequently found parasitized by tachnia flies and by horsehair worms of the genus *Mermis*.

The Jerusalem cricket, *Stenopelmatus longispina* Brunner (*S. californicus* Scudder, *S. histrio* Saussure, *S. irregularis* Scudder, *S. oculatus* Scudder, *S. terrenus* Rehn) (Figs. 62, 63), is the commonest form met with throughout the Pacific Coast Region from British Columbia through Washington, Oregon, California, Nevada, Arizona, Colorado, Utah, Wyoming, New Mexico, into Mexico. It is the largest species, measuring from 30 to 50 mm. The head, thorax, and legs are shining pale amber-yellow to brownish; the abdomen is shining amber-brown with wide, almost black bands across

[1] *Entomological News*, 34, 1923, p. 73.

the front margins of the segments above, while the venter is pale amber. It is readily recognized by the long, hind tibiæ which are armed with two or three outer and four or five inner spines. This species has been found to feed upon the tubers of potatoes growing on newly-cleared land and to feed on the same in confinement. It has also been shown that they will eat dead animal matter as well,[1] a habit common to many of the orthopterous insects.

FIG. 63.—Eggs of the Jerusalem cricket, *Stenopelmatus longispina* Brunner. (Photo furnished by H. H. P. Severin.)

The banded sand cricket, *Stenopelmatus fasciatus* Thomas, is much like the preceding species in size and color, but has from five to six spines on the outer margin of the hind tibiæ. It occurs in Montana, Idaho, Wyoming, and Utah.

The red sand cricket, *Stenopelmatus fuscus* Haldeman, is smaller than the two preceding species and often has a distinct reddish or pinkish tinge although the normal color is buff or pale amber brown with the characteristic dark abdominal bands. There are normally three inner and five outer spines on the hind tibiæ. This species ranges from the western foothills of the Rocky Mountains to the Pacific Coast, having been recorded in Washington, Idaho, Montana, Oregon, Wyoming, Colorado, California, Nevada, Arizona, and New Mexico.

The pictured sand cricket, *Stenopelmatus pictus* Scudder, is the smallest species, 20 to 30 mm., with much the same color as *S. longispina* Brunner, but with dark longitudinal marks on the occiput; and with smaller hind tibiæ normally armed with three inner and two outer spines. It occurs in the San Francisco Bay Region of California. C. D. Duncan has reared the tachnia fly, *Plagiprospherysa parvipalpis* Van der Wulp, from an adult at Palo Alto, California.[2]

GRYLLIDÆ.[3] Crickets, Tree Crickets, Mole Crickets, Ant Crickets.

The crickets are medium-sized, saltatorial insects usually with long, filiform antennæ, three-jointed tarsi, and spear-shaped ovipositor. The wings are fully developed, abbreviated or wanting; ocelli present or absent; the hearing organs usually on both sides of the front tibiæ. The stridulating organs of the males are located near the base of the dorsal surface of the tegmina and consist of a file and tympanum much as in the katydids. Crickets are variable in habits living in or on the ground or in bushes and trees, and feeding on vegetable and animal matter. They are nocturnal and the males are shrill and loud singers, being responsible for a great deal of the insect noise through the summer nights. The eggs are laid singly in the ground, or in rows or singly in the tissues of plants. Although often present in countless numbers they are not nearly so serious pests as many

[1] C. D. Duncan, *Entomological News*, 34, 1923, p. 73.
[2] *Entomological News*, 34, 1923, p. 77.
[3] S. H. Scudder, "The genus *Gryllus* on the Pacific Coast." *Psyche*, 9, 1901, p. 267.

of their relatives among the katydids and grasshoppers. Some of the house crickets destroy woolen goods and carpets, the field crickets sometimes devour the young plants, and the tree crickets, by their egg punctures, wrongly prune young trees and bushes, but as a whole the family is of little serious consequence.

GRYLLOTALPINÆ (Subfamily). Mole Crickets. **The knife mole cricket,** *Gryllotalpa cultriger* Uhler, is the only western representative of this subfamily. It is cinnamon brown with dark marks at the bases of the legs, and wide tegmina extending to cover the four basal abdominal segments. The length of the body is 27 mm. It occurs in California, Arizona, New Mexico (Texas).

TRIDACTYLINÆ (Subfamily). Sand or Pigmy Mole Crickets. **The minute mole cricket,** *Ellipes minuta* (Scudder) (*Tridactylus minutus* Scudder), is a small dark brown or blackish cricket with paler mottlings on the pronotum and all the femora and the middle tibiæ with pale cross bars; 4 to 5 mm. long. It frequents dry, grassy places and is often abundant in stubble fields of Central California. It also occurs in Arizona, New Mexico (Texas, U. S.).

MYRMECOPHILINÆ (Subfamily). Ant Loving Crickets.[1] The members of this subfamily are small, apterous crickets without ocelli or hearing organs, and with hind femora oval, compressed, and greatly enlarged. They live as guests in ant colonies and probably feed on the secretions of the ants' bodies.

Mann's ant cricket, *Myrmecophila manni* Schimmer, is pale yellowish brown and varies from 2 to 3 mm. long. It inhabits the nests of a large number of ants in Washington, California, Nevada, and Arizona.

The Nebraska ant cricket,[2] *Myrmecophila nebrascensis* Lugger (*M. nehawkæ* Scudder), is yellowish brown 1.3 to 2.6 mm. long. It occurs in the nests of a number of ants in Arizona, New Mexico (Texas, U. S.).

The Oregon ant cricket, *Myrmecophila oregonensis* Bruner (*M. formicarum* Scudder), varies from pale to dark brown in color and from 2 to 3.13 mm. in length. It is found in the nests of most of the common ants in British Columbia, Washington, Oregon, and California, ranging from the coast to the Cascade and Sierra Nevada Mountains.

GRYLLINÆ (Subfamily). Ground and Field Crickets. The small ground crickets belonging to the genus *Nemobius* are of a uniform brown color and often very abundant, feeding during the day on animal and vegetable matter, but particularly on pasture vegetation which is often cleaned up completely. The common western species are the **striped ground cricket,** *Nemobius fasciatus* (De Geer), which occurs in Montana, Wyoming, and Utah; **the Mexican ground cricket,** *N. mexicanus* Walker, often abundant in Imperial Valley, California, and in Arizona; **the Mormon ground cricket,** *N. cubensis mormonius* Scudder, found in Nevada and Utah; **the New Mexican ground cricket,** *N. neomexicanus* Scudder, occurring in California, Arizona, Colorado, Utah, New Mexico (Texas); and the Utah ground cricket, *N. utahensis* Scudder found in Utah.

[1] S. H. Scudder, "The Species of *Myrmecophila* in U. S." *Psyche*, 8, 1899, p. 423. M. Hebard, "A Rev. of N. A. Species of *Myrmecophila*." *Trans. Am. Ent. Soc.*, 46, 1920, p. 91.

[2] W. M. Wheeler, *Psyche*, 9, 1900, p. 111.

The closely related black ground cricket, *Miogryllus pictus* (Scudder) (*Nemobius*), occurs in Arizona and New Mexico, and the lined ground cricket, *M. lineatus* Scudder (*Gryllodes*), occurs in Nevada and Arizona.

The common house and field crickets belonging to the genus *Gryllus*[1] are now generally considered as a single species, commonly known as the **field cricket,** *Gryllus assimilis* (Fabr.) (Fig. 64), and the various forms throughout the country hitherto known as species are considered as varieties, races, or variants, or are indicated by symbols. In order to make use of available literature and records and to avoid confusion it has been thought best to list the old specific names most commonly used in different localities with the understanding that all are synonyms of the above. There has been so much difficulty in separating the various colored forms that the single specific name is most welcome. The species in question is very common throughout the country and is often known as the black cricket. In the warmer districts it appears at times in great numbers and may become a real nuisance in houses and public buildings especially on warm nights. The common house-inhabiting forms as well as those which are at times responsible for injury to young trees, vines, garden and truck crops, belong to this species. They may be controlled by using the poison bran mash as recommended for grasshoppers, with a slight increase in the amount of poison used.

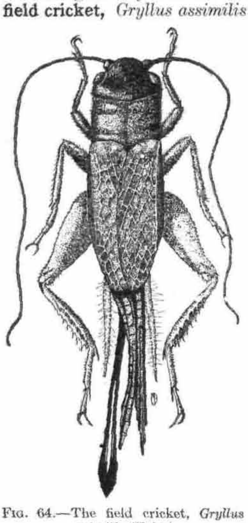

FIG. 64.—The field cricket, *Gryllus assimilis* (Fabr.).

The following variants may be listed for the Western States although many of them are strictly outside our region:

The typical form of *Gryllus assimilis* (Fabr.) is pale-yellowish. It occurs along the coast of Southern California.

Gryllus abbreviatus Serville. British Columbia.
alogus Rehn. Arizona, New Mexico.
armatus Scudder. Arizona, Utah.
integer Scudder. Oregon, California, Colorado, New Mexico.
lineaticeps Stål. California.
neglectus Scudder. Oregon, Arizona, Colorado. This is an Atlantic Coast form.
pennsylvanicus Burmeister. An eastern form reported in the west from many States.
personatus Uhler. Arizona, New Mexico.
signatipes Walker. Pacific Coast States.
vocalis Scudder. Southern California.

[1] J. A. G. Rehn and M. Hebard, "The Genus *Gryllus* in America." *Proc. Acad. Nat. Sci. Philad.*, 1915, p. 293.
W. S. Blatchley, *Orthoptera Northeastern Am.* Nature Pub. Co., Indianapolis, Ind., 1920, p. 696.

ŒCANTHINÆ (Subfamily). Tree Crickets.[1] The members of this subfamily are an interesting group of small, delicate crickets which are arboreal in habits and pale yellowish green or brownish in color to match their surroundings. The males have broad, flat tegmina folded horizontally over the back while those of the female are folded over the sides. The legs and antennæ are slender, the two basal joints of the latter bearing constant black markings which are an aid in separating the species. The males stridulate as do most of the crickets by rasping the bases of the wings together. They are nocturnal but are often found moving about during the day. The white, elongate, cylindrical, slightly curved eggs are laid, according to the species, singly in the bark or cambium of woody plants, in rows in the pitch of small stalks and twigs, and in two groups in the pith through a single puncture. The food consists of both plant and animal matter. Aphis, treehoppers, scales, and other small insects are rapidly devoured. Leaves, flowers, bark, and other parts of plants are also eaten, but tree crickets are generally considered beneficial rather than injurious, although the egg punctures may be sufficiently numerous in small branches to cause them to break.

The snowy tree cricket, *Œcanthus niveus* (De Geer), is a very pale green species in the adult form, the young being almost white. The length is 14 mm. to the tip of the abdomen. There is a single black spot on each of the first two antennal segments. It inhabits trees and bushes and is often found in apple orchards, apparently preferring the cultivated areas to the woodlands. The eggs are white or pale yellow, the cap with a long, finger-like projection, and are laid singly in the bark, or cambium near leaf axils of bushes and trees, often in apple, ash, pear, cherry, plum, prune, peach, and native and ornamental trees. A race in Oregon also oviposits in oblique rows in canes of blackberry, loganberry, raspberry, rose, and similar pithy plants according to B. B. Fulton. The song of the male is a clear whistle, "treat-treat-treat," in a high-pitched monotonous series. The nymphs feed on the flowers, young fruit, and foliage of fruit and other trees and are at times responsible for considerable damage by scarring the young fruit, particularly peaches in California and prunes in Washington. The snowy tree cricket has a wide distribution throughout North America and is found in many of the Western States, being reported in British Columbia, Washington, Idaho, Oregon, California, Utah, and Colorado (Mexico, Central America, Cuba).

The California tree cricket, *Œcanthus californicus* Saussure, is often mistaken for the snowy tree cricket in California. The male is light green or pale ochraceous, with the head and the dots on the pronotum and on the first and second antennal segments reddish; the females are pale yellowish-green to olive green. It is commonly taken in the orchards and native bushes throughout California, but nothing is known concerning its life history.

The black-horned tree cricket, *Œcanthus nigricornis* Walker (*O. fasciatus* Fitch), varies from pale green to almost entire black. The adults normally have the antennæ and venter of the abdomen black, while late seasonal forms also have the head, pronotum, and legs black. The length is 14 mm. It inhabits tall and rank growing plants and bushes along streams and in other damp places as well as in berry fields, vineyards, nurseries, and orchards. The eggs are laid in compact rows in pithy stems of raspberry, blackberry, loganberry, grape, and elder, but are also occasionally laid in woody twigs of elm,

[1] P. J. Parrott, *Jour. Econ. Ent.*, 4, 1911, p. 217.
B. B. Fulton, *Tree Crickets of N. Y.* Tech. Bul. 42, N. Y. Agr. Exp. Sta., 1915.

maple, peach, apple, and other trees. The number of eggs in a row varies from a few to nearly a hundred. Like the snowy tree cricket this species is widely distributed throughout the United States and is common in Oregon, California and Arizona.

The four-spotted tree cricket, *Œcanthus nigricornis quadrimaculatus* Butenmuller, is considered a valid species by some entomologists. There are apparently graduations in color between the preceding variety and this, the chief distinction of the latter being the two dark spots on each of the two basal antennal segments and the pale, rather than dark, ventral surface of the abdomen. Otherwise the general color and size are the same. The yellow eggs have the projections of the cap club- or finger-shaped. They are laid in loose rows in small pithy stems much like those of *O. nigricornis* Walker. It may be found in company with the black-horned tree cricket or more often in the small shrubbery of dry fields and foothills, on wild carrot, goldenrod, asters, white melilotus, and ragweed. It inhabits the entire country and is recorded in the west in British Columbia, Colorado, Utah, Arizona, and New Mexico.

The Argentina tree cricket, *Œcanthus argentinus* Saussure, somewhat resembles the snowy tree cricket in general color and shape. It has black spots only on the second joint. It is a South American species ranging through Mexico into Southern California, Arizona, New Mexico, and Texas and usually occurs on weeds and shrubs in open fields and prairies. It oviposits in pithy plants.

GRYLLOBLATTIDÆ.[1] The Grylloblattids. This is a small subfamily of wingless insects which have simple metamorphosis; biting mouth parts; slender, elongate, thysanuriform, somewhat hairy bodies; small compound eyes and no ocelli; legs fitted for running, 5-jointed tarsi without pulvilli; cerci long, slender, 8-jointed; ovipositor exserted. This family constitutes the order *Notoptera* of some authors. There is but a single species, *Grylloblatta campodeiformis* Walker, which occurs in the mountains at Banff, Alberta, and in Plumas County, California. The adults are honey-yellow covered with fine pubescence. The males measure 16.5 mm. and the females 30 mm. They occur under stones and somewhat resemble the *Campodea* from which the specific name is derived.

BLATTARIÆ (BLATTOIDEA) (Suborder)[2]

Cockroaches, Roaches

The members of this order are medium to large insects with simple metamorphosis and typical biting mouth parts. The bodies are regularly oval and very flat; the pronotum projecting forward over the head; the antennæ and legs long and slender. All forms are very swift runners. Many species are apterous, while perhaps the greater number have the leathery front wings and thin membranous hind wings, all of which are folded flat over the back in repose. The eggs are laid in peculiar masses or egg-cases, some of which are cylindrical or oval, while others resemble miniature shredded-wheat biscuits. The masses are often nearly half as

[1] E. M. Walker, Can. Ent., 46, pp. 93–99, 1914.

[2] S. H. Scudder, "Cat. Orthoptera N. A." *Smithsonian Miscl. Coll.*, 189, 1868.

James A. G. Rehn, "Studies in Am. *Blattidæ*." *Trans. Am. Ent. Soc.*, 29, 1903, p. 259.

R. Shelford, "*Blattidæ*." *Genera Insectorum, Fac.* 109, 1910.

A. N. Caudell, "Nearctic Orthopterous Insects." *Proc. U. S. Nat. Mus.*, 44, 1913, p. 600.

M. Hebard, "The *Blattidæ* of N. A. North of the Mexican Boundary." *Mem. Am. Ent. Soc.*, 2, 1917, p. 223.

This and the next two suborders, *Phasmida* and *Mantodea* are considered as Families by most students and the families listed under them as subfamilies.

large as the female and are usually carried about until ready to hatch, when they are dropped in a convenient place.

Cockroaches are normally vegetarians, feeding largely upon dry cereal products indoors or on vegetable matter in the field. The former are often serious pests in houses, but more particularly in restaurants and hotels, although they may be found in railroad sleepers, steamships, and nearly all other haunts of man. Their presence is no less disgusting than the roachy odor which they leave on everything they invade in the kitchen and pantry.

They are nocturnal in habits, hiding in cracks and in any dark place during the day and fairly swarming forth at night in search of food. Nothing escapes them and consequently they are very troublesome especially in hot, damp kitchens.

The field cockroaches are of no economic importance in this country.

The control of cockroaches is not always an easy task, but fumigating with hydrocyanic acid gas gives the most complete and satisfactory results. The work may be done during the night and the rooms made tight during the operation by placing strips of wet paper over the cracks around the doors, windows, and other openings. Sodium fluoride has largely replaced boric acid as a powder to sprinkle on the shelves and other places frequented by cockroaches. The material is effective as a fumigant as well as a poison, as it is taken into the mouth in cleaning the feet, by drawing them through the mouth parts.

A bait made by preparing a sweet gruel of cereal or cotton seed to which is added a yeast cake to start fermentation and a small amount of white arsenic is effective in killing the large cereal cockroaches which are troublesome in stores, warehouses, mills, and ships.

Cockroach book varnish may be prepared by shaking together one quart wood alcohol, 30 grains carbolic acid, and 15 grains corrosive sublimate. Let stand for 24 hours and apply as a varnish every six months. It should not be used on soft leather or bright-colored bindings.

KEY TO WESTERN FAMILIES

1. Middle and hind femora armed beneath along one or both margins with two or more distinct spines. . . . . **Blattidæ**
   Middle or hind femora, or both, unarmed beneath, or armed with hairs or bristles only, with one or two apical or subapical spines on one of both margins. 2

2. Arolium between claws distinct. . . . . **Panchloridæ** p. 105
   Arolium between claws minute or absent. 3

3. Apterous or the wings without or with an indistinct apical field. Anal field of wings with a single fold or apterous with the pronotum more or less pilose or hairy. . . . . **Corydidæ** p. 105
   Anal field of wing with two or more folds or apterous with the pronotum smooth **Panesthidæ** p. 106

BLATTIDÆ. Common Cockroaches.

The American cockroach, *Periplaneta americana* (Linn.) (*Blatta*) (Fig. 65, A), is a large, pale reddish brown species 1½ inches long, with paler markings on the pronotum and without a distinct yellow stripe on the elytra. It is a native of Central America and Mexico having extended

its range to include the middle and Western United States and may now be considered a cosmopolitan species. In the Southwestern States it is the commonest household roach.

The Australian cockroach, *Periplaneta australasiæ* (Fabr.) (*Blatta*) (Fig. 65, D), is similar to the American species but is slightly smaller, darker in color and with a distinct yellow humeral stripe on the elytra and a yellow margin on the pronotum. It is both a household and a garden pest, eating holes in clothing and book bindings, and attacking various

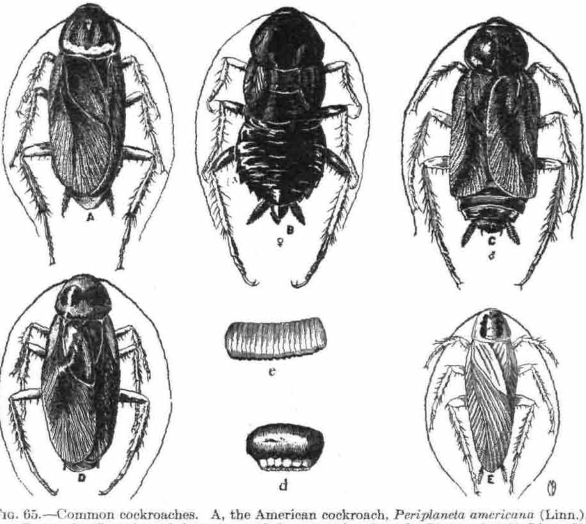

FIG. 65.—Common cockroaches. A, the American cockroach, *Periplaneta americana* (Linn.), B, female, C, male and d, egg case of the oriental cockroach, *Blatta orientalis* Linn.; D; the Australian cockroach, *Periplaneta australasiæ* (Fabr.); E, adult and e, egg case of the common cockroach, *Blattella germanica* (Linn.).

plants in greenhouses and gardens. It takes the poison bait freely and is not difficult to control. Like some other cockroaches, this species has been widely distributed by commerce throughout the world, although it is primarily a tropical and subtropical insect. In California it ranges as far north as San Francisco.

The oriental, black or Asiatic cockroach, *Blatta orientalis* Linn. (Fig. 65, B, C, d), is the common black roach of the house, about one inch long and dark brown. The wings of the female are rudimentary and those of the male, when folded, do not reach to the tip of the abdomen. It is

a cosmopolitan species spread throughout the world by commerce. It is likely to be found throughout the United States and in the west has been reported from Montana, Colorado, California, Arizona, and New Mexico.

The tropical cockroach, *Neosteleopyga rhombifolia* (Stoll) (*Dorylæa, Blatta, Stylopyga, Steleopyga*), is a cosmopolitan species within the tropics and ranges north throughout Mexico into Arizona. It is distinguished by the variegated thorax and the lateral elytra of the male.

The common cockroach, German roach, or crotonbug, *Blattella germanica* (Linn.) (*Blatta, Ectobia*) (Fig. 65, E, e), is the species most often met with in kitchens, bakeries, restaurants, hotels, and dwellings in this country. It is a small species less than one-half inch long, pale yellowish brown with two dark longitudinal stripes on the pronotum. This cosmopolitan species probably occurs in every State in the Union and is often present in great numbers. It feeds upon cereal and other stored products, runs over everything in the pantry and kitchen, leaves a distinct and offensive roach odor, and thus often becomes a serious nuisance.

The consobrine cockroach, *Ischnoptera consobrina* Saussure (*I. occidentalis* Sauss.), is a fuscous species 17 mm. long with brown wing nerves. It inhabits Central America, Mexico, and ranges into Texas, and is reported in Southern California.[1]

PANCHLORIDÆ. Tropical Cockroaches.

The green Cuban roach, *Panchlora cubensis* Saussure, is a pale green species often imported into the Western States in bunches of bananas from Central America. The writer has received a number of individuals from San Diego, Los Angeles, and San Francisco, California.

CORYDIDÆ.

The members of this family in the west are all included in the genus *Arenivaga*[2] (*Homæogamia*), and are winged or wingless. They occur under stones, cow chips, and so forth, and are mostly inhabitants of hot, arid regions.

The erratic roach, *Arenivaga erratica* (Rehn) (*Homæogamia*), is a medium-sized or small, reddish brown species 10–18 mm. long, which has the widest distribution of any, occurring in Southern California, Utah, Colorado, Arizona, New Mexico (Texas, Mexico). A large wingless female of this species was taken under a stone at Laguna Beach, California, in 1921, and determined by A. N. Caudell. The males are winged, 20 mm. long and pale brown, somewhat mottled with a dark median spot on the shield.

The Apache roach, *Arenivaga apacha* (Sauss.) (*Homæogamia apacha infuscata* Caudell), is closely akin to the erratic roach in size and color, although some forms are darker in color with paler mottlings on the tegmina. It occurs in Southern California and Arizona (Mexico).

The genital roach, *Arenivaga genitalis* Caudell, is the smallest species of the genus varying from 10 to 12 mm. long for the male, with darker markings on pronotum and distinct maculations on the tegmina, but the coloration is not so intensive as in *A. apacha* (Sauss.).

The Arizona roach, *Arenivaga grata* Hebard, is a large brown species 16–19 mm. long. It occurs in Southern Arizona (Mexico).

[1] Rehn and Hebard, *Proc. Acad. Nat. Sci. Phila.*, 61, 1909, p. 409.

[2] James A. G. Rehn, "A Revision of Orth. Genus *Homæogamia*." *Proc. Acad. Nat. Sci. Phila.*, 55, 1903, p. 177.

M. Hebard, "Revisionary Studies in the Genus *Arenivaga*." *Trans. Am. Ent. Soc.*, 46, 1920, p. 197.

PANESTHIDÆ.

A single species, *Cryptocercus punctulatus* Scudder, is reported from California by C. W. Woodworth.[1] It may be distinguished by the smooth pronotum and the absence of spines on the undersides of the femora.

PHASMIDA (PHASMOIDEA) (Suborder)[2]

Phasmids, Walkingsticks

The phasmids or walkingsticks are arboreal insects of medium to large size, usually with very slender stick-like bodies, simple metamorphosis and biting mouth parts. All of the forms in the United States, except *Aplopus mareri* Caudell in Florida, are wingless and so perfectly resembling their immediate surroundings as to be rarely observed. The majority of them mimic twigs while one species, the timema, in the west is protected chiefly by coloration. Some species are further protected by an offensive vapor or spray. The movements are usually very slow and all are herbivorous and arboreal, living chiefly in trees and shrubs. The eggs bear remarkable resemblance to seeds and are usually dropped to the ground where they lie dormant until they hatch usually in the spring of the following year. There is but a single brood annually. All of the western species are confined to the native vegetation and none of them have become destructive to cultivated plants.

KEY TO FAMILIES[3]

1. Antennæ not more than half as long as the anterior femora...... **Clitumnidæ**
   Antennæ distinctly longer than anterior femora........................... 2

2. Mesothorax never less than four times as long as the prothorax, generally more; tibiæ not furnished with sunken areola at the apex beneath..... **Bacunculidæ**
   Mesothorax never more than three times as long as the prothorax; generally less; tibiæ furnished with sunken areola at apex beneath....................... 3

3. Coxæ visible from above; tarsi five jointed.................... **Anisomorphidæ**
   Coxæ invisible from above; tarsi three-jointed................. **Timemidæ** p. 108

Three of these families are represented in the Western States.

CLITUMNIDÆ.

The Colorado walkingstick, *Parabacillus coloradus* (Scudder) (*Bacillus, B. carinatus* Scudd.), varies in color from testaceous to pale brown, often clouded dorsally and with pale fuscous stripes on the head; 48–70 mm. long. It inhabits Colorado, New Mexico, Arizona, California (Nebraska).

BACUNCULIDÆ.

The twig-like phasmid, *Pseudosermyle arbuscula* (Rehn) (*Sermyle*), is twiglike in form and reddish brown with gray markings. The hind femora

[1] *Guide to Calif. Insects.* Law Press, Berkeley, Cal., 1913, p. 319.

[2] S. H. Scudder, "Species of *Diapheromera* in U. S. and Canada. *Psyche*, 9, 1901, p. 187.
A. N. Caudell, "*Phasmidæ* or Walkingsticks of U. S." *Proc. U. S. Nat. Mus.*, 26, 1903, p. 863.

[3] After A. N. Caudell. *Proc. U. S. Nat. Mus.*, 26, 1903, p. 865.

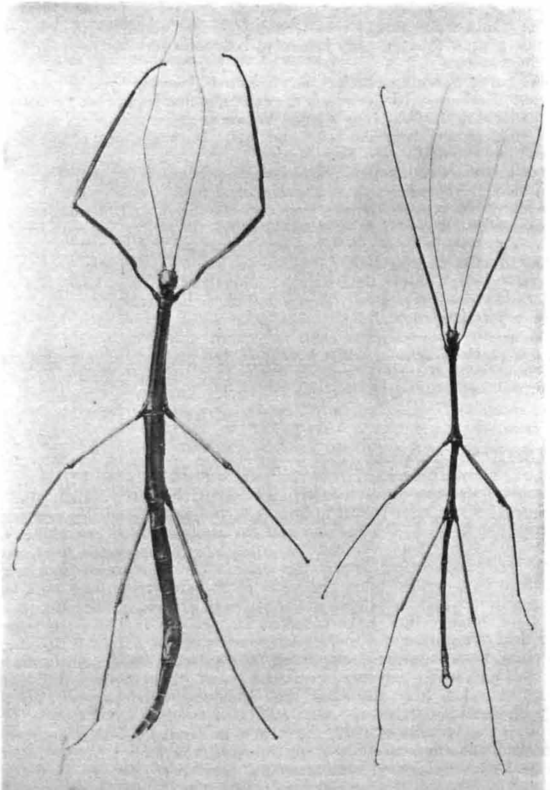

FIG. 66.—The Arizona walkingstick, *Diapheromera arizonensis* Caudell. Female left, male right. Natural size.

are very short; the length of the body is 54 mm. It is found in Southern California.

The truncate phasmid, *Pseudosermyle truncata* Caudell, is grayish brown, 73 mm. long, with a few body tubercles. Arizona and Southern California are its habitats.

The northern walkingstick, *Diapheromera femorata* (Say) (*Spectrum, Phasma, Bacunculus, Bacteria*), is the most abundant and best known form in the Eastern States. It is a large, brown or green species 92 mm. long, with long, slender twig-like body and legs. It ranges east of the Rocky Mountains extending into New Mexico.

The Arizona walkingstick, *Diapheromera arizonensis* Caudell (Fig. 66), is much like *D. femorata* (Say), but is smaller, slenderer, pale yellowish-brown with shiny black marks on the venter of the meso- and metathorax, and 76 mm. long. It occurs in Arizona, although the writer has seen what he believes to be this species in Southern California.

The Mesilla walkingstick, *Diapheromera mesillana* Scudder, is much like *D. arizonensis,* Caudell, but somewhat smaller, 55 mm. long, and of a uniform flavous green color. It is found in New Mexico.

Velie's walkingstick, *Diapheromera veliei* Walsh, agrees with *D. femorata* (Say) in size, general shape, and color, but differs in having the head slightly more elongate, middle femora of the male without gray bands, and the seventh abdominal segment of the male no longer than the ninth—in *D. femorata* (Say) it is noticeably longer. This species has much the same range as *D. femorata* (Say), extending west into New Mexico and Colorado.

TIMEMIDÆ. Timemas.

The California timema, *Timema californica* Scudder [1] (Fig. 67), is one of the most interesting western insects. It differs from the walkingstick in being smaller and more robust in form. According to Caudell it represents a transition between the earwigs and the walkingsticks, resembling the former in having short, ventrally attached legs; three-jointed tarsi; short broad head; and forcipal cerci in the males. The color varies from bright leaf-green to a decided pink, the males often being green with pink legs. The length varies from 14 mm. in the males to 22 mm. in the females; the males are slenderer and have incurved forcipal cerci. There has been a great deal of guessing and speculation concerning the habits of this insect and many have reported it as feeding on coniferous trees. All forms are arboreal, and while they may be found on all kinds of trees during the mating season in May and June, they apparently feed largely if not entirely on deciduous trees.

During the summer of 1922, the writer, in company with a number of students, made a general study of the timema in the Santa Cruz Mountains. The food plants observed were madrona, deciduous oaks, chiefly the live oak, valley oak, and Oregon oak and manzanita. G. F. Ferris reports it from the silk tassel bush, *Garrya elliptica* Dougl. It was noticed that the predominating green forms were taken on the green leaves, while the pink

[1] S. H. Scudder, *Can. Ent.*, 27, 1895, p. 30.
A. N. Caudell, *Proc. U. S. Nat. Mus.*, 26, p. 883, 1903. Orig. desc.
M. Hebard, *Ent. News*, 31, 1920, p. 127.
G. F. Ferris, *Ent. News*, 33, 1922, p. 282.

forms usually occurred on the reddish growing tips of the madrona, oaks, and manzanita.

During May and June the males and females were normally taken in copulation.

The species inhabits the Sierra Nevada Mountains and the Costala region of Central and Northern California and probably ranges into Oregon and possibly Washington, although it is only recorded in California. As the specimens are captured chiefly by beating, they are often completely overlooked by collectors.

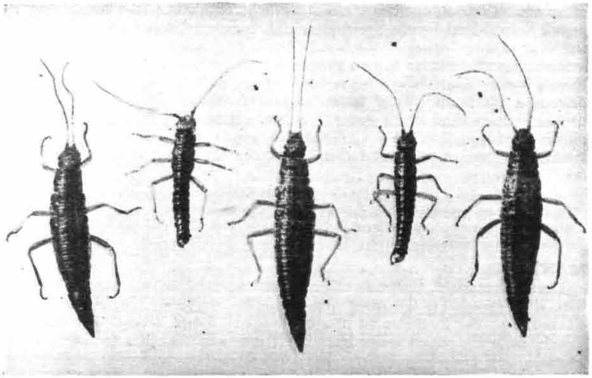

FIG. 67.—The California timema, *Timema californica* Scudder. The large ones are females and the smaller ones males.

The chumash timema, *Timema chumash* Hebard,[1] is closely related to *T. californica* Scudd. but is somewhat more robust and occurs in Southern California.

MANTODEA (MANTOIDEA) (Suborder)[2]

Praying Mantids, Soothsayers

The members of this order have long been considered and treated as a family of Orthoptera, but in recent writings the family has been separated along with many others as a distinct order. The mantids are medium- to large-sized insects with simple metamorphosis and biting mouth parts. They are characterized by having the front legs greatly enlarged and fitted

[1] *Ent. News*, 31, 1920, p. 130. Orig. desc.

[2] S. H. Scudder, "Index to *Mantidæ* of N. A." *Can. Ent.*, 28, 1896, p. 207.
James A. G. Rehn, "Studies in American Mantids." *Proc. U. S. Nat. Mus.*, 27, 1904, p. 561. *Ent. News*, 14, 1903, p. 328.
A. N. Caudell, "Nearctic *Mantidæ*." *Proc. U. S. Nat. Mus.*, 28, 1905, p. 463; 44, 1913, p. 605.

for catching and holding the prey which is eaten alive. These legs are held in front of the head in such a way as to indicate an attitude of prayer, which has given rise to the common names, but which in reality are proven to be for quite another purpose. There are two pairs of wings, the front pair or tegmina being leathery and for the protection of the fan-like hind wings. Some species are wingless and are found running through the dry grass, while the more characteristic mantids are quite large and arboreal in habits. As previously stated the food consists of living insects which are captured by watchful waiting and a sudden quick grasp with the powerful fore legs. Flies, bees, wasps, small butterflies, and in fact any kind of insect which happens within its reach, excepting the larger and the heavily chitinized forms, are taken. The eggs are deposited in the fall of the year in large masses attached to twigs or grasses and are covered with a thick, tough gray or brown mucus for protection. They hatch the following spring, there being but a single brood each year. Although mantids devour a large number of honey bees and other beneficial insects, they probably more than make up for this loss in the destruction of much greater numbers of injurious species. There are some six families of the order, of which but two are represented in the west. They are separated by Caudell[1] as follows:

KEY TO FAMILIES

Head unarmed; middle and hind tibiæ rounded above. . . . . **Mantidæ**
Head armed with a pair of long processes, as long as the head itself; middle and hind tibiæ carinate above. . . . . **Vatidæ** p. 111

MANTIDÆ.

The stick mantid, *Bactromantis virga* Scudder, is testaceous, the legs pale with dark bands on the front femora. The length of the female body is 43 mm. and the long slender pronutum is 11–15 mm. long. The length of the elytra of the males varies from 20–26 mm. It lives in Arizona, (Florida, Texas).

The minor mantid, *Litaneutria minor* (Scudder) (*Stagmatoptera*) (Fig. 68), is a rather small gray species which is fully winged in the male and with very short abortive wing stubs in the female. The latter is from 25–30 mm. long and the tegmina of the male, from 16–22 mm. This species is commonly found in the dry grass during the summer and fall months and is exceedingly agile and very difficult to capture. The species ranges in California, Arizona, and Colorado (Texas, Mexico).

There are four closely related species which may be synonyms of the above but which are separated by Caudell[2] as follows:

1. Wings of male without a sub-basal fuscous spot. . . . . **pacifica**
   Wings of male with a sub-basal fuscous spot. 2
2. Wings of male quite deeply fuliginous throughout. . . . . **obscura**
   Wings of male aside from sub-basal fuscous spot, lightly fuliginous. 3
3. Pronotum roughened in the female . . . . **minor**
   Pronotum smooth in the female. . . . . **borealis**

The obscure mantid, *Litaneutria obscura* Scudder, is undoubtedly a synonym of *L. minor* according to Caudell. It is recorded from California, Arizona, Colorado, New Mexico, Wyoming, and Utah.

[1] *Proc. U. S. Nat. Mus.*, 44, 1913, p. 605. Subfamilies are raised to family rank.
[2] *Proc. U. S. Nat. Mus.*, 28, 1905, p. 463.

The Pacific mantid, *Litaneutria pacifica* Scudder, is considered a distinct species. It is confined to California.

The boreal mantid, *Litaneutria borealis* Brun., is a rare species occurring in Colorado.

Skinner's mantid, *Litaneutria skinneri* Rehn, has abbreviated wings in the male and only stubs in the female. It occurs in California, Arizona, New Mexico (Texas).

The California mantid, *Stagmomantis californica* Rehn and Hebard, is a pale green or gray species 35–40 mm. long, living in California, Nevada, Arizona, New Mexico (Texas).

The Carolina mantid, *Stagmomantis carolina* (Linn.), is usually entirely green with the basal half of the tegmina fuscous. It has been taken in California, Arizona, New Mexico, Utah, Colorado (United States).

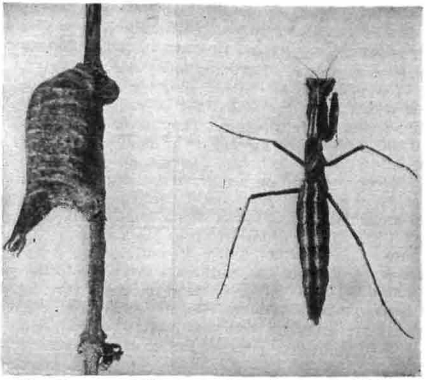

FIG. 68.—Mantids. Egg case of *Oligonyx mexicanus* Saussure and Zehntner from Texas at the left; female of the minor mantid, *Litaneutria minor* (Scudder), at right.

The bordered mantid, *Stagmomantis limbata* (Hahn), has the wings of the female fuliginous throughout and mottled with a dark patch at the apex. The costal area of the male is opaque. It is a Mexican species ranging into Arizona, New Mexico (Texas).

Stagmomantis gracilipes Rehn is known only in Arizona.

The solitary mantid, *Yersinia solitaria* Scudder, is a small species scarcely an inch long and completely apterous in both sexes. This species ranges in the Rocky Mountains and the eastern foothills and plains from Nebraska through Colorado into New Mexico and Arizona.

Yersinia sophronica Rehn and Hebard is a peculiar small, reddish form 14 mm. long, found on the bare hillsides of Arizona.

VATIDÆ.

Townsend's mantid, *Vates townsendi* Rehn,[1] is a large, handsome, reddish brown species with pale green tegmina marked with two oblique transverse dark bars, and with numerous reddish annulations on the legs. The length of the body is 61.7 mm. It occurs in Mexico ranging northward into Arizona.

Vates paræensis Saussure resembles the above and is found in Arizona (Mexico, Central America).

[1] James A. G. Rehn, *Proc. U. S. Nat. Mus.*, 27, 1904, p. 573. Orig. desc. A. N. Caudell, *Proc. U. S. Nat. Mus.*, 28, 1905, p. 464. Illustrations.

CHAPTER VIII

ISOPTERA (Order)[1]

(*Isos*, equal; *pteron*, wing)

Termites, White Ants

The members of this small order have simple or incomplete metamorphosis and biting mouth parts. They are small, flat, soft-bodied insects with or without eyes. Certain of the sexual forms have two pairs of similar, long, narrow wings which are folded flat over the back when at rest, but most of the individuals are wingless. They never live exposed to the light, but in total darkness in the ground or in dead logs, stumps, or building timbers. If it is necessary to invade places exposed to the light their lines of travel or places of operation are protected with earthen tubes or other coverings. Therefore they are mostly pale in color varying from pale yellowish to gray. Migrating forms which come out in the light are more heavily pigmented varying from brown to black in color.

Termites are social in habits, living in small or large colonies. The pale color together with their ant-like habits has given rise to the inappropriate name, white ants. The social life of these insects is very interesting, constituting a caste system of workers, soldiers, and reproductive individuals. The workers are mostly pale yellow or grayish, wholly apterous, blind, with soft bodies and large heads. They do the excavating work (Fig. 70), feed, and otherwise care for the young and the reproductive forms. Workers are not present in all species, in which cases the work is done by the developing nymphs of the reproductive forms. The workers represent forms of both sexes in which sexuality is never developed. The soldiers somewhat resemble the workers but have the head and particularly the mandibles heavily chitinized and enormously developed. They are blind abortive males and females like the workers, whose duty it is to protect the colony. In some genera the soldiers are replaced by nasuti which instead of having the powerful mandibles, have the head prolonged into a long pointed beak through which is exuded a fluid for defence or for making or repairing the earth-like tubes or passageways. The reproductive forms are varied and complicated. Among our western species there are three recognized forms. The normal or first form arises from nymphs with wing stubs or pads and

[1] H. Hagen, "*Neuroptera*. N. A." *Smithsonian Miscl. Coll.*, 1861, p. 1.
T. E. Snyder, *Biology of Termites of Eastern U. S.* Bul. 94, pt. II, Bur. Ent. U. S. Dept. Agr., Feb. 17, 1915. "Termites or White Ants in U. S." Bul. 333, *Prof. Paper*, U. S. Dept. Agr., Feb. 16, 1916. "White Ants as Pests in U. S. and Methods of Preventing their Damage." *Farmer's Bul.* 759, U. S. Dept. Agr., Oct. 9, 1916. "Colonizing Reproductive Adults of Termites." *Proc. Ent. Soc., Wash.*, 22, 1920, p. 109.
N. Banks and T. E. Snyder, "Revision of Nearctic Termites." Bul. 108, *U. S. Nat. Mus.*, pp. 1–228, 1920. Complete Bibliography.
W. M. Wheeler, "Social Life of Termites." *Scientific Mthly.*, 16, 1923, pp. 160, 312.

develops into brownish or black, winged, sexed adults which swarm, lose their wings, retaining the stubs, and become the true or normal kings and queens of the colonies. The queens do not grow to the immense, helpless, egg-producing forms known in the tropics and so often pictured, but increase in size slightly and retain the power of locomotion throughout their existence. The second form also with rudimentary wing pads are in reality also nymphs of the first form which have had their development retarded so that they do not reach sexual maturity until after the members of the first form have swarmed. They are mostly yellowish or gray in color, blind, and never leave the colonies. The third form has no wing pads at all, being worker-like sexed forms, pale yellowish or gray, and blind. The eggs are usually white, somewhat kidney-shaped, and from 1 to 1.5 mm. long. They are laid singly or in masses along the tunnels. New colonies are formed by swarming, which consists in the flight or migration of sexually mature males and females and the mating takes place after the female alights to a suitable place for founding the colony. In some species the colonies are found in dead wood in the shape of stumps, logs, telephone poles, fence posts, building timbers, and so on, while great numbers seek the ground.

Termites are among the most destructive insects known, in some parts of the world, particularly in the tropical regions. In the subtropical and temperate zones are found both injurious and non-injurious forms. The chief injury is to dead or dry wood, wood materials, and to a lesser degree to living vegetation.

Their attack may be entirely from the ground as in the case of the most destructive forms which normally require moisture present to enable them to live; others are not subterranean but are able to live in dry building timbers, poles, or posts without the presence of noticeable moisture, still others living in the ground cover living plants with tubes of mud in order to devour them in darkness. The injury consists in excavating and eating the wood which may be entirely destroyed, except the outer shell, causing building timbers to collapse, and the complete disintegration of logs, stumps, and so forth, and the death of living plants.

In the Western States termites seldom injure building timbers although many such cases are known. They are more serious in their attacks upon fence posts, telephone poles, and orchard trees and vines (Fig. 70). Taken all in all, however, they are not to be considered as particularly destructive to these objects except in extreme cases.

Control measures consist in preventing building timbers touching the ground or in using certain more or less repellent woods like redwood or by treating other woods with creosote, zinc chloride, or chloride of mercury. Redwood is normally exempt from the attacks of termites except when used as fence posts or pickets in which case the underground portions may become infested after 15 or 20 years. Fresh stakes are rarely attacked and this is a splendid reason for recommending redwood for grape stakes and fence posts. Some varieties of eucalyptus and black walnut are resistant to many species of termites. Telephone poles should also be treated throughout their full length to prevent attacks of both subterranean and aërial species. Fruit trees are often killed by the termites first starting in dead or injured wood. To prevent such attacks dead limbs and decayed

areas should be cleaned out and treated if below ground with asphaltum paint; if above ground with grafting wax. Grape cuttings may be severely injured where they are marked by stakes which first attract the migrating

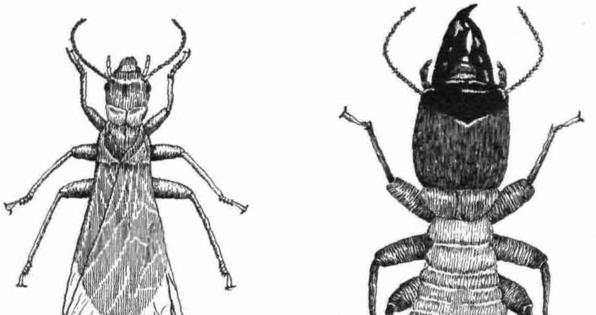

FIG. 69.—The large termite, *Termopsis angusticollis* Hagen. A, winged sexual form; B, soldier; C, nymph or toiler in the colony.

termites. The use of treated stakes eliminates this hazard. Infested building timbers may be cleaned by cyanide fumigation, by injecting carbon disulfid into the burrows, or by removing the infested timbers and protecting the replacements. In other words, sanitation is the most im-

portant factor in the normal control of these insects under our Western conditions. A further discussion of habits and control will be found under the different species.

KEY TO FAMILIES

Clypeus divided by a median line; radial sector without superior branches; fontanelle present or indistinct; gula as broad as long. . . . . **Termitidæ** p. 117
Clypeus not divided by median line; radial sector with one or more superior branches (rarely none); fontanelle lacking; gula longer than broad . . . . . **Kalotermitidæ**

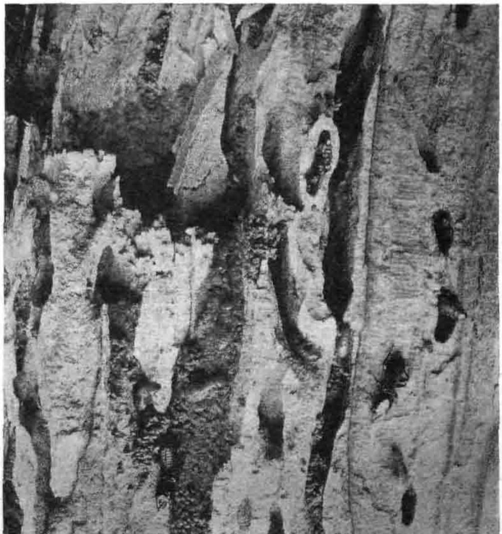

FIG. 70.—The large termite, *Termopsis angusticollis* Hagen. Young sexual forms or toilers and soldiers and typical work and frass in an old apple tree.

KALOTERMITIDÆ.

The large termite, *Termopsis angusticollis* Hagen (*Termes castaneus* Walker) (Figs. 69, 70), is among the largest and least destructive of the termites. The colony consists of yellowish or grayish soldiers with brownish heads and black mandibles; and three forms of reproductive individ-

uals. There are no true workers, the work being done by the grayish or whitish nymphs of the apterous third form. The soldiers are from 15 to 19 mm. long and the winged individuals from 23 to 25 mm. to the tip of the folded wings. This and other species of the same genus are not subterranean in habits, but infest dead stumps, logs, trees, or dead portions of living trees. These are entered after swarming through wounds or crevices. The excavations usually follow the grain of the wood, but the whole interior may be honeycombed. They are frequently found in the dead heartwood of old fruit trees or in any dead areas and may extend their operations into living tissues causing some damage in orchards. This species, however, is not the form most often found in such places, but rather the smaller species of the genus *Reticulitermes*. A number of infestations in pine building timbers have been noted, but this type of injury is also rare.

The large termite is most often found in pine stumps and logs, but it may also occur in oak, fir, as well as in fruit and other trees, always working in the dry, hard, or decayed and rotten wood.

A scarabæid beetle, *Valgus californicus* Horn, is an inquiline of this termite in California.

The distribution is practically confined to the Pacific Coast region of British Columbia, Washington, Oregon, California, and Nevada.

The Nevada termite, *Termopsis nevadensis* (Hagen) (*T. angusticollis nevadensis* Hagen), is much like the large termite, but is smaller and darker, the abdomen of the winged forms being very dark brown or almost black. It lives and works much like the former species and is often confused with it. It was observed swarming in great numbers from a pine stump and log in Mt. Lassen National Park at sunset on a warm day, May 31, 1924.

The distribution is much larger, comprising most of the States west of the Rocky Mountains, having been observed in British Columbia, Washington, Idaho, Montana, Oregon, California, Nevada, and Utah. A termitophilous silphid beetle, *Platycholeus leptinoides* (Crotch), is associated with it in Oregon, California, and Nevada.

The white-headed termite, *Termopsis laticeps* Banks, is likely to be confused with the two preceding forms, resembling them in size, color, and habits. It works in the dead wood of poplar, cottonwood, alder, willow, and so forth, in the high mountains of Arizona and New Mexico.

The occidental termite, *Kalotermes occidentis* (Walker) (*Termes, Calotermes*), some what resembles the members of the genus *Termopsis* in general form and habits. The castes are about the same, there being no true workers. The soldiers in this species have vestigial wing pads. It is the largest member of the genus in our region, the soldiers varying from 14 to 15 mm. and the winged forms from 18 to 20 mm. to the tip of the wings. The color is amber-brown, the wings pale grayish. Members of the genus *Kalotermes* directly infest hard dry wood boring tunnels which do not follow the grain and which may entirely decompose the insides of trees, logs, stumps, and so on, although they are seldom serious pests. Swarming occurs at night during the month of August. The species is somewhat limited in distribution, occurring in Southern California, Arizona, Lower California, and Mexico. The dead palo verde trees are commonly infested by it.

The Mexican termite, *Kalotermes marginipennis* (Latreille) (*Termes mexicanus* Walker), is a yellowish-brown species 11–12 mm. long to the tip of the wings. It occurs chiefly in Mexico, Texas, and New Mexico, but is reported from California by Hagen.

The minor termite, *Kalotermes minor* (Hagen) [*K. marginipennis* (Latreille) var. *minor* Hagen], is readily distinguished by the bluish-black color of the winged forms

which also have dusky wings. They measure from 11 to 12 mm. to the tip of the wings. The soldiers vary from reddish-brown to almost black. It is a common species in the Southwest ranging from New Mexico through Arizona and into California as far north as San Francisco Bay. All kinds of dead wood are invaded including ash, walnut, poplar, cottonwood, cypress, palo verde, willow, and pine telephone poles. Swarming occurs in July in Arizona.

Hubbard's termite, *Kalotermes hubbardi* Banks, differs from the minor termite in having a pale brownish color in the winged forms which are 13 mm. long to the tip of the wings. The soldiers are yellowish with castaneous heads, and from 6 to 8 mm. long. This species is often associated with *K. minor* (Hagen) in dead logs or stumps, or cottonwood, poplar, walnut, willow, and palo verde trees. It also invades the giant desert cactus and the rafters of adobe buildings. Coniferous as well as deciduous wood is excavated with extensive tunnels which may completely honeycomb the entire interior. The species inhabits Northern Mexico, Lower California, Arizona, and California as far north as San Francisco Bay, thus overlapping with *K. minor* (Hagen). Swarming occurs about the same time in both species, in July in Arizona, and later in the northern limits of the range. It is nocturnal and attracted to lights.

Bank's termite, *Kalotermes banksi* Snyder, is a small dark yellowish brown species, 6 mm. long exclusive of the wings. It inhabits Arizona.

TERMITIDÆ.

Members of the genus *Reticulitermes* are small and often serious pests. They are subterranean in habits colonizing in the ground but extending their excavations into wood above-ground wherever moisture is present. They cannot live in dry wood as can larger species belonging to the genera *Termopsis*, *Kalotermes*, *Neotermes*, and *Cryptotermes* which are not subterranean. They normally feed upon decaying roots or other organic matter in the soil, but are often very destructive to building timbers, furniture, rugs, carpets, linoleum, and other similar objects wherever there is sufficient moisture to permit excavations. The tunnels usually follow the grain of the wood, but they may so honeycomb the wood as to reduce the infested parts to frass and powder.

These small termites often live in immense colonies and have the typical social organization composed of the blind, apterous, dirty white workers, which have a musty odor and travel in military formation; the large headed soldiers; and the three forms of reproductive individuals with the third or apterous form rare. The first form or winged individuals are usually very dark or black in color. One of the interesting habits of these termites is the swarming reaction of some species at the time the pollen is ripe in certain plants particularly the dogwood, *Cornus* spp. Besides the control measures suggested at the beginning of this chapter it is well to point out here the value of dryness in the extinction of colonies of the species of *Reticulitermes* because moisture is absolutely essential to their existence. The use of concrete, stone, or brick for foundations and the treatment of timbers near the ground with asphaltum to keep out the moisture are the most important considerations.

The golden termite, *Reticulitermes aureus* Snyder, is pale yellowish to light brown in the adult winged form. The length of the dewinged forms is nearly 5 mm. It inhabits Arizona.

The clear-winged termite, *Reticulitermes claripennis* Banks, is often confused with *R. lucifugus* (Rossi). The head and thorax are nearly black, the femora are black, while the rest of the legs and the palpi are pale. The length to the tips of the wings is about 10 mm. It ranges from Kansas south through Texas to Mexico and west through New Mexico into Arizona.

The yellow-footed termite, *Reticulitermes flavipes* (Kollar) (*Termes*), has been recorded in Washington, Colorado, Arizona, and New Mexico. It ranges chiefly east of the Mississippi River and its western limits according to Banks and Snyder are not far west of the Mississippi River. It has probably been confused with the western species as there is no authentic record of its occurrence west of the Rocky Mountains.

The western termite, *Reticulitermes hesperus* Banks (Fig. 71), is the commonest and most destructive western species. The winged forms are very dark brown to black and 8 or 9 mm. long to the tip of the wings. The soldiers have an unusually long head being about twice as long as broad. The damage done by this species is considerable and widespread. As it is a subterranean form its attack originate under the soil. It is

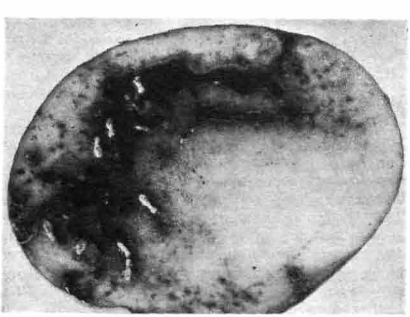

FIG. 71.—Workers of the western termite, *Reticulitermes hesperus* Banks, and injury to potato.

commonly found tunneling posts, stakes, and timbers, under, or which come in contact with, the surface of the ground. It has done much damage to young grapevines throughout California, having first invaded the bamboo stakes beside the vines. Fruit trees, potatoes, globe artichoke plants, dead trees and plants of all kinds are also invaded. Swarms often appear from cracks in the sidewalks or holes in the ground considerable distances from any apparent food material. The winged swarms appear at various times in February, March, May, and June, with the blooming of the western flowering dogwood as observed by Snyder. This species is recorded in Washington, Oregon, Nevada, California, and Lower California.

The obscure termite, *Reticulitermes humilis* Banks, is 9 mm. long to the tips of the wings, the heads of the soldiers being less elongated and more hairy above than those of *R. hesperus* Banks. It is a destructive wood borer, invading the stems of Opuntia cactus and the wood and stumps of palo verde, pine, yucca, mesquite, oak, sycamore, and other plants. It occurs in Arizona and swarms in June and July.

In the variety *hoferi* Banks the soldiers have smaller heads and longer and more slender mandibles. This termite infests oak and cactus in Arizona.

The lucifugous termite, *Reticulitermes lucifugus* (Rossi) (*Termes, Leucotermes*), is a European species, recorded from the east and often reported from California, but this species does not occur in our region and all western references to it pretain to

other species, chiefly to the western termite, *R. hesperus* Banks, as pointed out by Banks and Snyder.

The black-legged termite, *Reticulitermes tibialis* Banks, is distinguished by the almost wholly black shining body, black tibiæ and the black bases of the wings. The winged forms are 10 mm. long to the tips of the wings. The soldiers are brownish-yellow. Like the preceding members of the genus, it is subterranean in habits, being commonly found in dead wood and under logs, stones, and cow chips. It is a widely distributed form occurring in practically all of the States west of the Rocky Mountains and east to Iowa. It is recorded in Montana, Idaho, Colorado, Utah, New Mexico, Arizona, California, and Nevada, and is often found at high elevations. Swarming occurs in the spring and fall of the year.

The swollen-legged termite, *Reticulitermes tumiceps* Banks, is similar to *R. tibialis* Banks, but is larger with the femora more swollen. It occurs in Arizona.

The Arizona termite, *Amitermes arizonensis* Banks, is a pale brown species. The body is covered with short yellow hairs and the wings are narrow and twice as long as the body which is 9 mm. long to the tip of the wings. The soldiers are pale yellow. This species works chiefly in the dead stalks of the agave or century plant and yucca, often covering the plant with mud to conceal its work. It also occurs under cow chips. Swarming occurs in July in Arizona. The species occurs in Southern California and in Arizona.

The California termite, *Amitermes californicus* Banks, is shining light brown in the winged form, 8 to 8.5 mm. long; the wings are long and narrow, and ciliated on the margins. The soldiers are yellowish or grayish with the head little longer than broad. This is a nocturnal swarming species which appears on the wing in June and July. It invades dead yucca, cactus, and century plants, and may also be found under cow chips. The distribution includes Southern California and Arizona.

The tube-forming termite, *Amitermes tubiformans* (Buckley) (*Termes*), gets its name from the habit of constructing tubular mud galleries on the outside surfaces of the infested plants through which the insects travel in complete darkness. The winged forms are brown, the wings being nearly twice as long as the body. It is about the same size as the two preceding species. These termites live in the ground and normally feed upon the roots and tops of grasses and a wide variety of plants. They cover their work with galleries of mud and excrement and may thus extend their activities considerable distances above ground. They work at night and are particularly active after rains. They feed not only on dead wood and other dry vegetable matter, but also attack healthy growing plants and may destroy large areas of vegetation on grazing lands. In Texas they are particularly injurious to sorghum, oats, vegetables, and other cultivated crops during dry years. In Arizona, A. W. Morrill[1] has recorded attacks on young citrus trees, the termites extending their mud galleries from 1½ to 2 feet up the trunks of the trees. The species occurs in Texas, New Mexico, and Arizona. Swarming occurs during the daytime in July.

The confused termite, *Amitermes* (?) *confusus* Banks, is 14–15 mm. long to the tip of the wings. It occurs in Southern Arizona.

The long-nosed termite, *Constrictotermes tenuirostris* (Desneux) (*Termes, Eutermes*), belongs to a genus of peculiar termites in which the soldier caste with jaw-like mandibles are replaced by the nasuti or nasutus caste which have the head modified into a long pointed beak or nose-like process through which is exuded a fluid for defense and for making and mending the earthen galleries or tubes which extend into the ground. They live in the ground being often found under cow chips and swarm at night after a rain, starting colonies in the freshly softened ground. The food consists of dead and living plants which are attacked at night. The winged adults of this species are pale amber brown, densely clothed with short yellow hair and 20 mm. long to the tip of the wings. It occurs in Arizona, Texas and Mexico.

The brown nasute termite, *Constrictotermes cinereus* (Buckley) (*Termes*), very much resembles the preceding species. The winged forms are amber yellow with darker abdomen, covered with yellow hair. The nasuti have small black heads, brown thorax and abdomen, and long antennæ and legs. The workers have large brown heads. This species has practically the same habits and distribution as the preceding.

[1] *Ninth Ann. Rept.*, Ariz., Com. Agr. and Hort., 1917, p. 42.

CHAPTER IX

ZORAPTERA (Order) [1]

(*Zoros*, pure; *apterous*, wingless)

Zorapterans

Zorapterans are minute apterous and winged insects with simple metamorphosis; biting mouth parts; slender legs for running, with 2-jointed tarsi, each with two claws; strong mandibles; 9-jointed and moniliform antennæ; blind in apterous forms and with compound and simple eyes in the winged forms; wings, when present, long and slender, the fore pair much larger than the hind, with few branching veins, and may be shed; cerci short, fleshy, unsegmented; body soft, partly chitinized, and somewhat hairy. These insects somewhat resemble termites in structure and habits and live in small or fairly large colonies under the bark of trees. Little is known regarding their habits. There is known within the very small order but a single family, *Zorotypidæ* and a single genus *Zorotypus*. The six known species occur in Africa, Java, Ceylon, Costa Rica, and in Florida and Texas. *Zorotypus hubbardi* Caudell and *Z. snyderi* Caudell occur in Florida, while the former has also been taken in Texas.

[1] F. Silvestri, "Desc. of a New Order of Insects." *Bul. del Lab. di Zoöl. Gen. Agraria della R. Scuola Sup. d'Agr. in Portici*, 7, pp. 193–209, 1913.
A. N. Caudell, *Can. Ent.*, 50, pp. 375–381, 1918. *Proc. Ent. Soc. Wash.*, 22, pp. 84–97, 1920.

CHAPTER X

EMBIIDINA (Order)[1]

(*Embios*, lively)

Embiids

This is a very small order of insects with simple or incomplete metamorphosis and biting mouth parts. The members are long and slender,

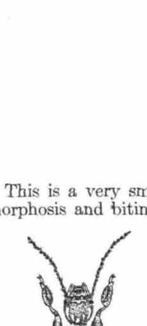

FIG. 72. — The California embiid, *Embia californica* Banks. Apterous female.

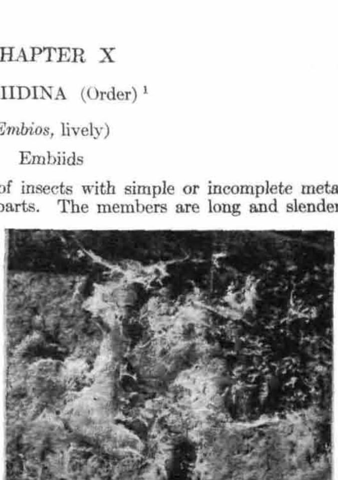

FIG. 73.—The California embiid, *Embia californica* Banks. Adult, young and characteristic webbing and runways on the underside of a cow chip in early spring.

somewhat flattened, apterous or with two pairs of wings in the males which are held flat over the body at rest, a pair of short cerci, and the tarsi of the front legs greatly enlarged and modified to hold the spinning organs located in them.

The food is apparently decayed organic matter through which the burrows run in all directions.

[1] H. A. Hagen, "Monograph of *Embidina*." *Can. Ent.*, 17, pp. 141, 171, 190, 260, 1885.

J. C. Chamberlin, "Rev. of the Genus *Anisembia*," etc. *Proc. Cal. Acad. Sci.* (4), 12, pp. 341–351, 1923.

Many of the species are tropical, but there is one member known in California and a few in the Southern States.

The California embiid, *Embia californica* Banks[1] (Figs. 72, 73), is a pale yellowish brown species with reddish markings. The length of the mature females averages 10–15 mm. The males have small or abortive wings, and are 7 mm. in length.

This species is abundant in the grass or under stones, cow chips, or other objects on the surface of the ground, or in old logs during the months of February and March. Its presence is always indicated by the extensive webbings over the surrounding objects as the under sides of stones or boards, or on the grass around such objects. Cow chips may be honeycombed throughout with the extensively webbed burrows.

The females are almost cylindrical, being somewhat flattened dorsally. They occur in grassy fields and on the hillsides when the grass is growing and the ground is moist. The males were originally described from Southern California and the females were taken in great numbers in the San Francisco Bay region of California.

[1] N. Banks, *Trans. Am. Ent. Soc.*, 32, p. 1, 1906. Orig. desc. This species probably belongs to the genus, *Anisembia*.

CHAPTER XI

CORRODENTIA (Order)[1]

(*Corrodens*, gnawing)

Psocids, Bark Lice, Book Lice

The members of this family are small insects with simple or incomplete metamorphosis, biting mouth parts, apterous or with two pairs of thin membranous wings, having a few simple longitudinal and cross veins, held roof-like over the body at rest, and with the front pair the larger. The integument is thin and the body somewhat flattened. The psocids normally feed on dead organic material or fungi and occur on or under the bark of trees, which has given rise to the name, bark lice. Other species inhabit the leaves, particularly those covered with the black smut fungus. This is particularly true of many of the species along the coastal region, which usually spin a thin web above the colony of the young. Still others may be found on the ground and under stones. A few species inhabit buildings and feed upon cereal products and the paste and glue in book bindings, the latter habit being responsible for the name, book lice.

The eggs may be laid singly or in great masses which are protected by a dark-gray matrix or covering. The young psocids are peculiar little insects with wide abdomen, narrow thorax, and large head. They are often gregarious in habits living under thin webs and are fleet runners. The adults, though fully winged in many species, prefer to rely upon their speed on foot in most cases, resorting to flying only when hard pressed or when migrating to new surroundings.

The psocids are, with the exception of those species infesting books and cereal products, practically harmless and for this reason together with their small size, are little known. I do not believe that the life history of a single western species is fully known and the great majority are still unnamed.

There are two families separated as follows:

Wings well developed; ocelli present.............................. **Psocidæ** p. 124

Wings absent or abortive; ocelli absent....................... **Atropidæ** p. 124

[1] H. Hagen, "Syn. *Neuroptera* N. A." *Smithsonian Miscl. Coll.*, 1861, p. 7. "Some *Psocina* of U. S." *Psyche*, 3, 1881, pp. 195, 206, 219. "Tarsal and Antennal Characters of *Psocidæ*." *Psyche*, 4, 1883, p. 52.

S. F. Aaron, New *Psocidæ*." *Trans. Am. Ent. Soc.*, 11, 1883, p. 37. *Proc. Am. Ent. Soc. Acad. Nat. Sci. Philad.*, 1886, p. 12.

N. Banks, *Trans. Am. Ent. Soc.*, 19, 1892, p. 330; 30, 1904, p. 100; 32, 1905, p. 6; 34, 1908, p. 257; *Jour. N. Y. Ent. Soc.*, 11, 1903, p. 236; 15, 1907, p. 166. Cat. *Neuropteroid Ins. U. S. Am. Ent. Soc.*, 1907, p. 6.

R. E. Snodgrass, "Mouthparts of *Corrodentia*." *Trans. Am. Ent. Soc.*, 31, 1905, p. 300.

ATROPIDÆ. Book Lice.

The members of this family are for the most part found in and about buildings and may be troublesome to books in libraries and to cereals in houses, mills, and stores, as well as to museum insect and plant specimens.

The cereal psocid, *Troctes divinatorius* (Müller) (Fig. 74), is a small wingless, pale to nearly black species 1 mm. long. It is common in cereal products and about build-

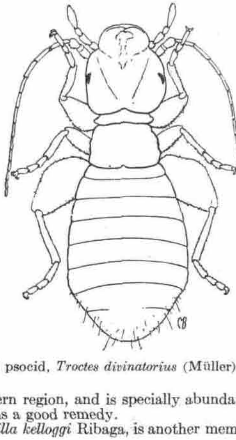

FIG. 74.—The cereal psocid, *Troctes divinatorius* (Müller). A wingless species.

ings throughout the western region, and is specially abundant in California. Fumigation with carbon disulfid is a good remedy.

Kellogg's psocid, *Lepidilla kelloggi* Ribaga, is another member of this family recorded in California.

PSOCIDÆ. Psocids, Bark Lice.

The members are much more numerous in this than in the preceding family, and are often abundant on the leaves and bark of native ornamental and fruit trees and shrubs, as well as on the ground and under stones.

The orange psocid, *Cæcilius aurantiacus* (Hagen) (*Psocus*), is an orange-reddish species 1 mm. long with clear wings. It occurs in the San Francisco Bay Region, California (U. S.).

The clear psocid, *Cæcilius clarus* Banks, is pale yellowish, 3 mm. long, with a few dark spots on the wings. It is found on trees in Berkeley, California.

The citrus psocid, *Cæcilius* sp., is a pale yellow species with transparent wings, often abundant on the leaves of orange and lemon trees in Southern California.

The western psocid, *Elipsocus occidentalis* Banks, is a dark species 2.5 mm. long, with a dark cloud in the middle of the wings. It inhabits British Columbia.

The punctate psocid, *Elipsocus punctatus* Banks, is a yellow and brown species 3 mm. long, having clear wings with broad pterostigma. It occurs in the San Francisco Bay Region, California.

The Colorado psocid, *Myopsocus coloradensis* Banks, is a dark species 4.5 to 5 mm. long, with pale spots on the head and thorax, and a broad dark band across the wings. It is found under stones in Colorado.

The spotted psocid, *Myopsocus maculosus* Banks, is brown and yellowish, 5 mm. long, with many small brown spots on the wings. It is taken on leaves in Berkeley, California.

The ten-spotted psocid, *Peripsocus californicus* Banks (Fig. 75), is the most abundant species along the central California coast. It is but 2 mm. long, grayish-brown, with 10 small brown spots scattered over the otherwise hyaline wings. It is common on the leaves of all kinds of trees and shrubs in California.

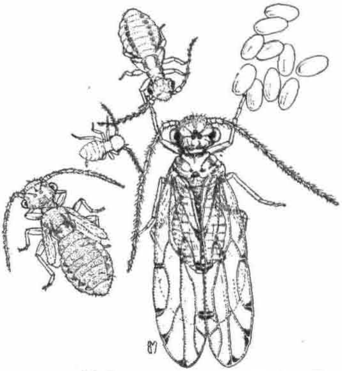

FIG. 75.—The ten-spotted psocid, *Peripsocus californicus* Banks. Eggs, young and adult. Such a family group is common beneath a frail web on leaves.

The smoky-winged psocid, *Peripsocus fumosus* Banks, is 3 mm. long to the wing tips, pale yellowish to dark brown, and characterized by the smoky wings which have a small pale area at the tip of the posterior branch of the median vein. Colorado is its habitat.

The California psocid, *Psocus californicus* Banks, is a black species with white and yellow marks and clear wings with dusky bands across the basal parts. The length is 3.2 mm. It occurs in Southern California.

Cockerell's psocid, *Psocus cockerelli* Banks, is pale yellow and brown with hyaline wings, inhabiting New Mexico.

The consperse psocid, *Psocus conspersus* Banks, is dark brown to black, legs and antennæ paler, 3 mm. long, and wings sprinkled with small brown spots. It is found in Arizona.

The Oregon psocid, *Psocus oregonus* Banks, is dark with yellowish head and amber legs, 3.5 mm. long, wings hyaline. It occurs in Oregon, Washington, and New Mexico.

The cloudy winged psocid, *Cerastipsocus trifasciatus* (Prov.) (*Psocus speciosus* Aaron, *P. nigrofasciatus* Kolbe), is a dark species with paler appendages and three dark fascia on the front wings. It inhabits New Mexico (U. S.).

CHAPTER XII

MALLOPHAGA (Order) [1]

(*Mallos*, a hair; *phagein*, to eat)

Bird Lice, Biting Lice.

The members of this rather large order are small wingless insects with simple or incomplete metamorphosis and biting mouth parts. The bodies are heavily or weakly chitinized, flattened, and usually have broad heads with short antennæ which are free and exposed or concealed in a groove beneath. The color varies from white to yellow, tan, brown, dark reddish or almost black, with or without distinctive markings. Most are swift runners and are fitted with claws and hairs to enable them to pass through hairs and feathers of the host rapidly, while others are quite slow and cling to the feathers by their jaws. In habits they are ectoparasitic living on warm-blooded animals including chiefly birds, but quite a number also live on mammals. They feed upon the hair, feathers, epidermal scales and the dried blood collecting around wounds of the host, and while they do not actually attack the flesh, they become very irritating and are often present in sufficient numbers to cause great discomfort and even death. As they cannot fly they are distributed largely by personal contact or from the nests and roosts to the young and to other species.

[1] Herbert Osborn, Bul. No. 7, Div. Ent. U. S. Dept. Agr., 1891, p. 30. Bul. No. 5, n. s. Div. Ent. U. S. Dept. Agr., 1896, p. 189.

V. L. Kellogg, "New *Mallophaga* I & II," *Proc. Cal. Acad. Sci.*, 6, 1896, pp. 31, 431. "List of N. A. Species of *Mallophaga*." *Proc. U. S. Nat. Mus.*, 22, 1900, p. 39. "*Mallophaga*." *Genera Insectorum*, 66, 1908.

V. L. Kellogg, B. L. Chapman, R. E. Snodgrass, "New *Mallophaga* III." *Occ. Papers*, 6, *Cal. Acad. Sci.*, Feb. 1899.

V. L. Kellogg, B. L. Chapman, "*Mallophaga* of Birds of Pacific Coast of N. A." *Jour. N. Y. Ent. Soc.*, 10, 1902, p. 20.

V. L. Kellogg, J. H. Paine, "*Mallophaga* from Birds and Mammals." *Ent. News*, 21, 1910, p. 459. "*Mallophaga* from Cal. Birds." *Ent. News*, 22, 1911, p. 75.

V. L. Kellogg, W. M. Mann, "A Third Collection of *Mallophaga* from Alaska Birds." *Ent. News*, 23, 1912, p. 12.

V. L. Kellogg, G. F. Ferris, *The Anoplura and Mallophaga of N. A. Mammals*, Leland Stanford Jr. Univ. Pub., Univ. Press, 1915.

R. E. Snodgrass, "A Rev. of Mouth Parts of *Mallophaga*." *Trans. Am. Ent. Soc.*, 31, 1905, p. 297.

J. H. Paine, "*Mallophaga* from Birds at Laguna Beach, California." *First Ann. Rept. Laguna Marine Lab.*, Pomona College, 1912, p. 174.

L. Harrison, "The Respiratory System of *Mallophaga*." *Parasitology*, 8, 1915–16, p. 101. "The Genera and Species of *Mallophaga*." *Parasitology*, 9, 1916, p. 1.

E. A. McGregor, "Six New Species *Mallophaga* from N. A. Mammals." *Ann. Ent. Soc. Am.*, 10, 1917, p. 167.

A. W. Baker, "*Mallophaga*. *Rept. Canadian Arctic Exped.*, 1913–18, 3, Sept. 12, 1919.

The writer is greatly indebted to Prof. G. F. Ferris for making new drawings illustrating members of this order.

As they are able to live but a short time off a warm-blooded host it is not clear how some species have become so widely distributed to the different hosts.

The elongated eggs or nits are glued singly on the hairs or feathers of the host and the young appear much the same as the adults. They breed under very favorable conditions, having a fairly uniform heat from the body of the host to make them comfortable under most climatic conditions. The broods are overlapping and there are several to many generations a year.

The chief damage to the host is through constant irritation. The species affecting sheep and goats are responsible for a considerable loss in partially cutting or weakening the fibre of the wool and thus reducing its length and quality.

Control of the bird-infesting species consists in supplying dust baths which give slight relief to domestic poultry. The use of sodium fluoride powder, 1 ounce diluted with 5 ounces of flour well mixed, is effective in the control of these pests on both fowls and mammals. In this diluted condition the material should be sprinkled on and thoroughly rubbed into the feathers or hairs. For poultry the use of sodium fluorid alone is recommended. In this case the powder is applied by the "pinch" method, *i. e.*, a small pinch of material is applied directly to the body in numerous places, about 12 pinches being sufficient for a fowl. Sodium fluoride kills by contact fumigation and remains sufficiently long on the host to kill the young upon hatching from the eggs. It is the most satisfactory material for fowls and small mammals like dogs and cats.

For larger animals like sheep, goats, horses, and cattle the diluted powder may be used during the winter when dipping cannot be resorted to, but during the summer the coal tar dips may be used alone, or better, the following Bureau of Animal Industry standard arsenical dip, which controls ticks, mange mites, and sucking lice as well, may be used:

White Arsenic	8 pounds
Sal Soda	24 "
Pine Tar	1 gallon
Water	500 "

As already stated, the order *Mallophaga* is a large one, but is of considerable economic importance. We are therefore listing practically all of the western species together with their hosts.[1]

BOOPIDÆ.

The kangaroo louse, *Heterodoxus longitarsus* (Piaget) (*H. armiferus* Paine),[2] has the 4-segmented antennæ concealed beneath the head, which is conical and broader than long. The tarsi are 2-clawed. The original host is the kangaroo, but the louse has been taken a number of times on dogs in the San Francisco Bay Region, California, where according to G. F. Ferris it can be a very severe pest, even killing the host. Ferris also reports it as the most serious dog parasite in South Africa.

[1] The birds are listed by their accepted common names as given in the following authoritative works: *American Ornithologists' Union Check List of N. A. Birds* 1910. Joseph Grinnell, "A Distributional List of the Birds of California." *Pacific Coast Avifauna*, 11, 1915.

[2] J. H. Paine, *Ent. News*, 23, 1912, p. 362.

GYROPIDÆ.[1]

The oval guinea pig louse, *Gyropus ovalis* Nitzsch, has a single large well-developed claw on each foot. It is found on guinea pigs in North and South America and Europe, wherever the host is domesticated.

The guinea pig louse, *Gliricola porcelli* (Linn.) (*G. saviæ* Schrank, *Gyropus gracilis* Nitzsch), is much like the former, but has smaller claws. The color is pale yellow with head and abdomen darker and transverse dark marks on the dorsum of the latter. It is common on guinea pigs throughout the country.

MENOPONIDÆ.[2]

The common hen louse, *Menopon gallinæ* Linn. (*M. pallidum* Nitzsch, *M. trigonocephalum* Olfers), is a small species from 1 to 1.5 mm. long, rather robust with long head and short legs. The color is pale yellow. It is a very active, abundant, and widely distributed poultry parasite infesting domestic poultry including chickens, ducks, and pigeons.

The large body poultry louse, *Menopon stramineum* Nitzsch (*M. biseriatum* Piaget), is a common form often associated with the former. It is more elongated in form, larger, 2-2.5 mm. long, and with longer legs and shorter head. The hosts are chickens, turkeys, pigeons, and peacocks. It occurs throughout North America and Europe.

Menopon alaskense Kell. & Chap. From American dipper and California pine grosbeak. Alaska.
- *alternatum* Osborn. From buzzard. California.
- *corporosum* Kell. & Kuw. From ruddy turnstone duck and red or northern phalarope. Alaska.
- *decoratum* Kellogg. From white-tailed kite. California.
- *distinctum* Kell. & Chap. From ash-throated flycatcher and northern cactus wren. California.
- *infrequens* Kellogg. From Delaware and glaucous gulls. Alaska, California.
- *irrumpens* Kell. & Chap. From short-tailed albatross. California.
- *kuwani* Kell. & Chap. From Brandt cormorant. California.
- *loomisi* Kellogg. From white-winged scoter. California.
- *mæstum* Kell. & Chap. From golden-crowned and Samuels song sparrows. California.
- *monostæchum* Kellogg. From imported silver pheasant. California.
- *navigans* Kellogg. From short-tailed albatross. California.
- *numerosum* Kellogg. From Pacific and Rodgers fulmars. California.
- *paululum* Kell. & Chap. From dark-bodied, black-vented and pink-footed shearwaters. California.
- *persignatum* Kell. & Chap. From California and blue-fronted jays. California.
- *petulans* Kell. & Chap. From black-vented shearwater and dark-bodied shearwater. California.
- *robustum* Kellogg. From coast bush-tit. California.
- *striatum* Kellogg. From ptarmigan. Alaska.

Colpocephalum assimile Piaget. From whooping crane. Colorado.
- *chrysophæum* Kellogg. From Samuels song sparrow. California.
- *flavescens* Nitzsch. From Siberian Eagle, Siberia; bald and golden eagles, Alaska; desert sparrow hawk, California.
- *fumidum* Kellogg. From coast bush-tit. California.

[1] H. E. Ewing, "Taxonomy, Biology and Distribution of *Gyropidæ*." *Proc. U. S. Nat. Mus.*, 63, art 20, pp. 1-42, 1924.

[2] G. F. Ferris, "The Mallophagan Family *Menoponidæ*." *Parasitology*, 16, pp. 55-66, 1924.

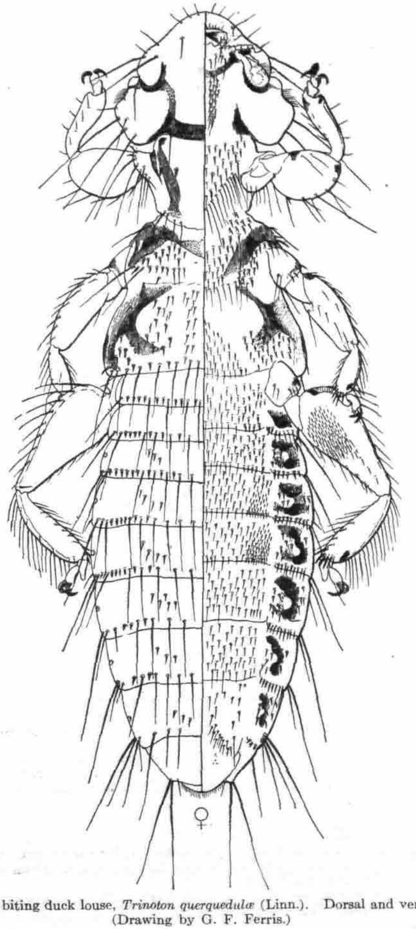

FIG. 76.—The biting duck louse, *Trinoton querquedulæ* (Linn.). Dorsal and ventral aspects. (Drawing by G. F. Ferris.)

Colpocephalum funebre Kellogg. From Heermann gull, Alaska; from glaucous gull, California.
grandiculum Kell. & Chap. From California brown towhee and Heermann song sparrow. California.
kelloggi Osborn. From buzzard. California.
morsitans Kellogg & Mann. From pectoral sandpiper. Alaska.
osborni Kellogg. From white-tailed kite. California.
pœtulum Kell. & Kuw. From ruddy turnstone duck. Alaska.
perplanum Kell. & Chap. From tufted puffin. California.
pingue Kellogg. From black-footed albatross, Alaska; short-tailed albatross, California.
spinulosum Piaget var. *minor* Kell. & Chap. From sanderling. California.
stictum Kell. & Paine. From Wilsons snipe. California.
subæquale Nitzsch. From western crow, California. (Various crows, Europe.)
timidum Kellogg. From black-bellied plover. California (U. S.).
unciferum Kellogg. From California brown and American white pelicans. California (U. S.).

Myrsidea dissimilis (Kellogg) (*Menopon dissimile* Kell.). From California cliff swallow. California.
funerea (Kell. & Chap.). From California jay, Gairdner woodpecker, western-evening grosbeak. California.
incerta (Kellogg). From russet-back thrush, willow goldfinch, western lark sparrow, Vigors wren, American goldfinch. California.
ridulosa (Kell. & Chap.). From California yellow warbler. California.
subæqualis Lyonet (*M. mesoleuca* Nitzsch). From northern raven. Alaska.
var. *americana* (Kellogg). From Western or American crow. California.

Tetrophthalmus consanguineus (Piaget) (*Menopon*). From American white pelican. California.
incompositus (Kell. & Chap.). From Brandt cormorant California.
linearis (Kellogg). From California brown pelican. California.
titan (Piaget) var. *impar* (Kellogg). From the gular pouch of American white pelican. California, Nevada and other Western States.

Trinoton lituratum Nitzsch. **Goose louse.** Small, white, robust, common on wild and domestic ducks and geese. California (North America, Europe).
querquedulæ (Linn.) (*T. luridum* Nitzsch) (Fig. 76). **The biting duck louse.** The common duck louse, large 4 to 5 mm. long, triangular head with lateral swellings, dark transverse bands on dorsum of the abdomen. On domestic and wild ducks, Pacific loon. Alaska, California (United States).

Eureum malleus (Nitzsch). (*Menopon*). From cliff swallow and Northern cactus wren. California.

Pseudomenopon insolens (Kellogg). (*Menopon*). From American eared grebe, California (Tern, U. S.).
pacificum (Kellogg). From American coot or mud hen, Pacific loon, pied-billed grebe, common loon, shoveller duck. California.
tridens (Nitzsch). From pied-billed grebe, California clapper rail, Virginia rail, American eared grebe, Western grebe. California, Washington.

Ancistrona vagelli (Fabr.) (*A. gigas* Piaget). **The giant bird louse.** The broadest known species. From the pink-footed, dark-bodied and black-vented shearwaters, Pacific and Rodgers fulmars. California (Europe).

LÆMOBOTHRIIDÆ.

Læmobothrion loomisi Kell. & Chap. The largest biting bird louse, measuring 9.7 mm. It is pale brown with dark markings. From white-fronted goose. California.
nigrum Burmeister (*L. atrum* Nitzsch). From American coot or mud hen. California (Europe).

RICINIDÆ.

Ricinus diffusus (Kellogg) (*Physostomum*). From golden crowned and Aleutian, savannah or sandwich sparrows, California; from Point Pinos junco, Washington.
microcephalus (Kellogg). From California linnet and house finch. California.
pallidus (Kellogg). From Oregon junco. Washington (U. S.).
sucinaceus (Kellogg). From western flycatcher. California.
Trochilœcetes prominens (Kell. & Chap.). (*Physostomum*). From Costas humming bird. California.

TRICHODECTIDÆ.

The cattle red louse, *Trichodectes bovis* (Linn.) (*T. scalaris* Nitzsch) (Fig. 77), is much smaller than the blue sucking lice of cattle. The color is reddish with the abdomen yellow or whitish with distinct dark transverse dorsal bands. It is often abundant and serious on calves and cattle, but is not as bad as the sucking louse. It is found throughout the country.

The biting dog louse, *Trichodectes canis* De Geer (*T. latus* Nitzsch), is a small species 1 mm. long with wide body. It is common the world over and attacks dogs, being particularly troublesome to puppies.

The biting goat louse, *Trichodectes capræ* Gurlt (*T. climax* Nitzsch),[1] is a broad species 1.5 mm. long. It is a very common species on goats in California and throughout the country.

The biting horse louse, *Trichodectes equi* Linn. (*T. parumpilosus* Piaget), is a common, often abundant species on the horse, mule, and ass throughout North America and Europe. It is a bright chestnut brown species with darker transverse bands on the abdomen. It is more numerous in the early spring and collects around the neck, tail, and between the legs where the hair may be removed.

The gopher louse, *Trichodectes geomydis* Osborn (*T. californicus* Chapman), occurs on the pocket gopher in California, on the pocket rat in Arizona, and on the spiny-haired pocket mouse in Lower California. It also occurs throughout North America and Central America.

Herms' louse, *Trichodectes hermsi* Kellogg and Nakayama,[2] is a pale yellowish-brown species 2.4 mm. long, the body sparsely clothed with short, fine hairs. It is larger than the other goat-infesting species and is abundant on angora goats in California. It has also been taken on a young merino goat in Marin County, California.

The badger louse, *Trichodectes interruptofasciatus* Kellogg and Ferris, infests the badger in California and has been reported from skunk in South America.

King's louse, *Trichodectes kingi* McGregor, infests the weasel in Montana.

The skunk louse, *Trichodectes mephitidis* Packard, occurs on skunk and weasel in California and Arizona (United States).

The mountain louse, *Trichodectes monticolus* McGregor, infests skunks in the Sierra Nevada Mountains of California.

The eight-spotted louse, *Trichodectes octomaculatus* Paine (*T. procyonis* Neumann), infests the raccoon in British Columbia and California.

The biting deer louse, *Trichodectes odocoilei* McGregor, occurs on the white-tailed deer in Montana.

The biting sheep louse, *Trichodectes ovis* Linn. (*T. sphærocephalus* Olfers),[3] has a wide short head, wider than long and rounded in front; dark abdominal bands; 1.4 to 1.6 mm. long. It attacks various parts of the body of sheep and is cosmopolitan.

The fox louse, *Trichodectes quadraticeps* Chapman, infests the fox in California.

[1] *Trichodectes limbatus* Gervais of the angora goat is believed to be identical with *T. capræ* Gurlt by some. It is listed as a separate species by Harrison. *Loc. cit.*, p. 70.

[2] *Psyche*, 22, 1915, p. 34. Orig. desc.

[3] M. C. Hall, *Farmers' Bul.* 1150, U. S. Dept. Agr., Dec. 1920.

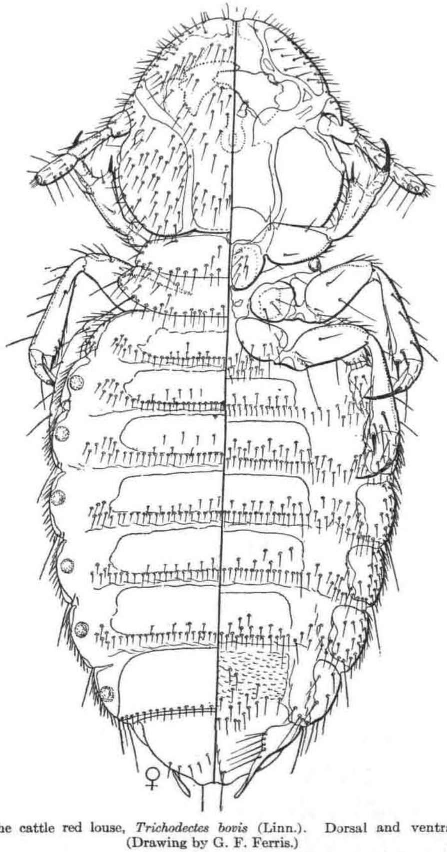

FIG. 77.—The cattle red louse, *Trichodectes bovis* (Linn.). Dorsal and ventral aspects. (Drawing by G. F. Ferris.)

The biting cat louse, *Trichodectes subrostratus* Nitzsch, is distinguished by the pointed head with the short hair-like furrow on the underside. It is a small species slightly over 1 mm. long, which infests domesticated and wild cats in California.

The Colorado gopher louse, *Trichodectes thomomyus* McGregor, has been taken on the pocket gopher in Colorado.

Trichodectes thoracicus Osborn occurs on the ring-tailed cat in California, and *T. tibialis* Piaget on the black-tailed deer in California.

The porcupine louse, *Eutrichophilus setosus* Giebel, infests the porcupine in Alaska and California (North America, Europe).

PHILOPTERIDÆ.

Goniodes cervinicornis Giebel. From imported silver pheasant. California, Europe.
- *corpulentus* Kellogg and Mann. From pectoral sandpiper. Alaska.
- *descrepans* Kellogg and Paine. From Aleutian sandpiper and ptarmigans. Alaska.
- *mammillatus* Rudow. From rock and willow ptarmigans, Alaska; from valley quail, California; from Columbian sharp-tailed grouse, Washington.

The European pigeon louse, *Goniocotes bidentatus* Scopoli (*G. compar* Nitzsch), is a small species 1 mm. long, whitish with brown margins. It is common on domestic pigeons throughout the country.

The large chicken louse, *Goniocotes gigas* Taschenberg (*G. abdominalis* Piaget) (Fig. 78), is 3 mm. long, broad, with head, thorax, and legs yellowish with dark spots and margins, and the abdomen with pale black-bordered fascia on the dorsum. It is common on chickens throughout North America and Europe.

The lesser chicken louse, *Goniocotes hologaster* Nitzsch, is only 1 mm. long, but otherwise much like the large chicken louse. It is also a common chicken infesting species throughout North America and Europe.

Goniocotes creber Kellogg has been taken from imported silver pheasant in California.

The variable chicken louse, *Lipeurus caponis* (Linn.) (*L. variabilis* Nitzsch), is a long, slender white louse with black markings measuring 2 mm. in length. It is common on chickens throughout North America and Europe.

The California quail louse, *Lipeurus californicus* Kellogg and Chapman, is taken from plumed partridge, valley and mountain quail in California.

The partridge louse, *Lipeurus docophoroides* Piaget, infests California quail, plumed partridge, and domestic fowls in California and Colorado.

The turkey louse, *Lipeurus gallipavonis* Geoffroy (*L. polytrapezius* Nitzsch), is a rather large, elongated species from 3 to 3.5 mm. long. The color is pale yellowish-white with black markings, dusky trapezoidal marks appearing on all the abdominal segments except the last. It infests turkeys and occurs throughout the United States.

Lipeurus introductus Kellogg. From introduced pheasant silver. California.
- *protervus* Kellogg. From the rock or willow ptarmigan. Alaska.

Philopterus acutipectus (Kellogg) (*Docophorus*). From rhinoceros auklet. California.
- *alaskensis* (Kellogg and Kuwana). From Ross gull. Alaska.
- *americanus* (Kellogg). From American dipper. Alaska (Europe).
- *atricolor* (Kellogg). From ancient and marbled murrelets. California.
- *californiensis* (Kellogg). From California and northern white-headed woodpeckers, Williamson sapsucker. California.
- *calvus* (Kellogg). From California murre. California.
- *ceblebrachys* (Nitzsch). From snowy owl. Alaska, Washington (United States).
- *colymbinus* Denny. From Pacific loon, red-throated diver or loon. California.
- *conicus* (Denny) (*Docophorus fuliginosus* Kellogg). From black-bellied and semipalmated plovers, pink-footed shearwater. California.
- *cursor* (Nitzsch). From short-eared owl, Alaska; from long-eared owl, California; (screech owls, United States; owls, Europe).
- *dentatus* (Scopoli) (*Docophorus icterodes* Nitzsch) (Fig. 79). **The red duck louse.** A dark reddish species 1 mm. long which is common and often abundant upon wild and domestic ducks and geese. From American coot or mud hen, surf scoter, ruddy duck, red-breasted merganser, greater and lesser scaup ducks, domestic ducks and geese, California; from Eider duck and Hutchins goose, Alaska. (Also occurs throughout North America and Europe.)

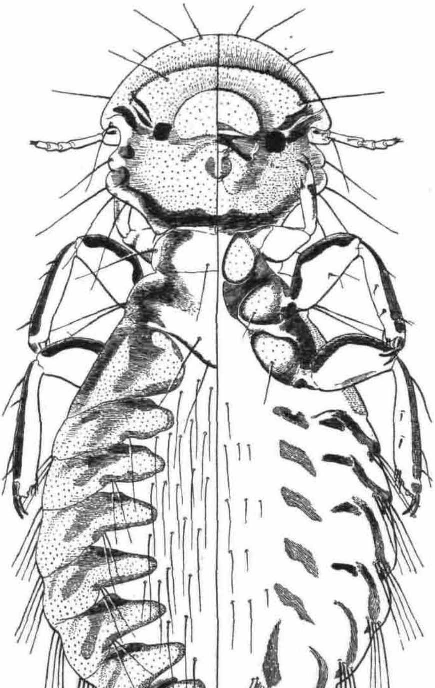

FIG. 78.—The large chicken louse, *Goniocotes gigas* Taschenberg. Dorsal and ventral aspects. (Drawing by G. F. Ferris.)

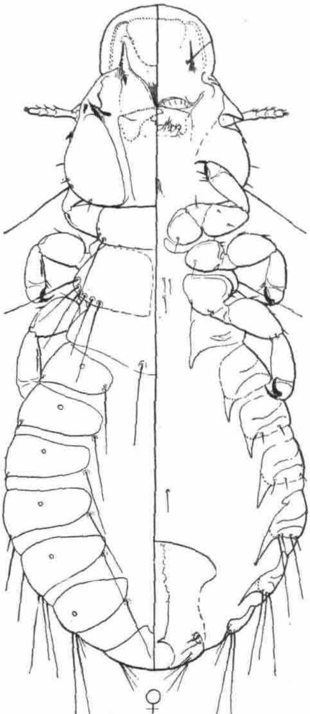

FIG. 79.—The red duck louse, *Philopterus dentatus* (Scopoli). Dorsal and ventral aspects. (Drawing by G. F. Ferris.)

Philopterus distinctus (Kellogg). From northern raven, Alaska; from western raven, California.

excisus (Nitzsch) var. *major* (Kellogg). From cliff and tree swallows. California.

fuscoventralis (Osborn). From ash-throated flycatcher. California (United States).

fusiformis (Denny). From Aleutian sandpiper, Alaska; from least sandpiper, California (sandpipers, United States).

gonothorax (Giebel) (*Docophorus lari* Denny). From gulls, loons, American grebe, California; from Pacific kittiwake, Aleutian sandpiper, gulls. Alaska.

graviceps (Kellogg). From Pacific loon, American coot or mud hen. California.

incisus (Kellogg). From pied-billed grebe. California.

insolitus (Kellogg). On Cassin auklet, Aleutian murrelet. California.

melanocephalus (Nitzsch). On royal tern, Pomeraine jæger. California, Alaska.

mirinotatus (Kellogg and Chapman). From Sierra junco. California.

mirus (Kellogg and Chapman). From Vigors wren, Townsend warbler. California.

monachus (Kellogg and Paine). From Virginia rail. California.

montereyi (Kellogg). From Cassin auklet, ancient and marbled murrelets. California.

nævius (Giebel) (*Docophorus pictus* Giebel). From Golden Eagle. California.

occidentalis (Kellogg). From Pacific and Rodgers fulmars, surf scoter. California.

pertusus (Nitzsch). From American eared grebe, American coot or mud hen. California (North America).

platyrhynchus (Nitzsch). From Western red-tailed hawk. California.

procax (Kellogg and Chapman). From pigeon guillemot. California.

pustulosus (Nitzsch). From parasitic jæger. Alaska (Europe).

quadraticeps (Kellogg). From American coot or mud hen, American eared grebe. California (United States).

rostratus (Nitzsch). From American barn owl. California (owls, United States and Europe).

rufus (Kellogg). From ash-throated flycatcher. California.

rutteri (Kellogg). From long-tailed chickadee. Alaska.

sialii (Osborn). From bluebird. Colorado.

singularis (Kellogg and Chapman). From Nuttalls woodpecker, varied thrush. California.

syrnii (Packard) (*Docophorus speotyti* Osborn). From spotted and burrowing owls, California; from owls, Alaska (United States).

subflavescens (Geoffroy). From snow bunting, Lapland longspur, Gambels and song sparrows, jay, Alaska; from Shumagin fox sparrow, black-headed and California grosbeaks, Sierra junco, black-billed magpie, California (United States, Europe on many perching and song birds).

validus (Kellogg and Chapman). From black-vented shearwater. California.

Degeeriella actophila (Kellogg and Chapman) (*Nirmus*). From sanderling. California.

americana (Kellogg and Chapman). From pigeon guillemot, American eared and pied-billed grebes. California.

atrimarginata (Kellogg and Chapman). From Pacific kittiwake. Alaska.

brachythorax (Giebel). From cedar waxwing. California (United States).

complexiva (Kellogg and Chapman). From Bairds and Aleutian sandpipers, knot, Alaska; from least sandpiper, sanderling, California.

connexa (Kellogg and Mann). From red phalarope. Alaska.

cordata (Osborn). From marbled godwit. California (North America).

domestica (Kellogg and Chapman). From barn swallow. California.

ductilis (Kellogg and Chapman). From Western flycatcher. California.

euprepes (Kellogg and Chapman). From ruddy turnstone duck. California, Alaska.

eustigma (Kellogg). From Anna humming bird. California.

Degeeriella felix (Giebel). A pretty white species with conspicuous black dots. From Heermann gull. California.

fœda (Kellogg and Chapman). From ash-throated flycatcher, Say phœbe, western kingbird, long-tailed chat, California shrike, Phainopepla, black phœbe, western mourning dove. California.

furva (Nitzsch). From Virginia rail, Wilson snipe. California.

fusca (Nitzsch). From American sparrow hawk, western red-tailed hawk, white-tailed kite, desert sparrow hawk, California; from Western grosbeak, Washington (North America, Central America, Europe on hawks, kites and eagles).

hebes (Kellogg). From royal tern. California.

hiaticulæ (Mueller). From semipalmated plover. California.

incœnis (Kellogg and Chapman). From Aleutian sandpiper, Alaska; black-bellied plover, California.

infecta (Kellogg and Chapman). From red phalarope. Alaska.

lautiuscula (Kellogg and Chapman). From bell sparrow. California.

longa (Kellogg). From barn and cliff swallows. California.

maritima (Kellogg and Chapman). From Cassin and rhinoceros auklets, ancient murrelet. California.

normifer (Grube) (*Nirmus triangulatus* Nitzsch). From pomeraine jæger, California; from parasitic jæger, Alaska. (Europe).

opaca (Kellogg and Chapman). From semipalmated plover. California.

ornata (Grube) (*Nirmus lineolatus* Nitzsch). Gulls. California (North America, Europe).

pacifica (Kellogg and Chapman). From tufted puffin, pigeon guillemot, dark-bodied shearwater. California.

præstans (Kellogg). From royal tern. California.

punctata (Nitzsch). From many kinds of gulls. California (North America, Europe, Asia).

splendida (Kellogg). From California thrasher, roadrunner. California.

vulgata (Kellogg). From California purple finch, California linnet, golden-crowned and intermediate sparrows, California brown towhee, California blue grosbeak, western lark sparrow, Lazuli bunting, mountain and Marin chickadees, Western bluebird, California yellow and lutescent warblers, black-chinned humming bird, blue-fronted jay, American dipper, Western and ash-throated flycatchers, Shumagin fox sparrow, California; from Gambels sparrow, Alaska. (United States on many passerine birds.)

Rallicola advena (Kellogg) (*Oncophorus*). From Pacific loon, American coot or mud hen. California.

bisetosa (Piaget). From Virginia and Clapper rails. California.

var. *californicus* (Kellogg and Chapman). From Virginia and Clapper rails. California.

cuspidata Scopoli (*Oncophorus minutus* Nitzsch). From American coot or mud hen. California.

Strigiphilus remotus (Kellogg and Chapman) (*Oncophorus*). From great gray owl. Washington.

Ornithobius cygni (Linn.). **The white swan louse.** Large species 4 mm. long, white with dark spots on margins of the four middle segments. Common on swans throughout North America and Europe.

Esthiopterum assessor (Giebel) (*Lipeurus*). From California condor, California. (King vulture, Central America.)

baculoides (Paine)? From mourning dove. California.

columbæ (Linn.). (*Lipeurus buculus* Nitzsch). **The pigeon louse.** A common slender, reddish-brown species 2 mm. long. Infests wild and domesticated pigeons and doves throughout Europe and N. America.

concinnum (Kellogg and Chapman). From short-tailed albatross. California.

crassicorne (Scopoli) (*Lipeurus constrictus* Kellogg, *L. squalidus* Nitzsch). **The squalid duck louse.** Large pale yellow species, slender, 4 mm. long. Common cosmopolitan species on wild and domesticated ducks.

Esthiopterum diomedeæ (Fabricius) (*Lipeurus densus* Kellogg, *L. ferox* Giebel). A large striking species, 9 mm. long. From short-tailed albatross, California; from black-footed albatross, Alaska. (Albatross, Europe.)

diversum (Kellogg) (*Lipeurus limitatus* Kellogg). From black-vented, dark-bodied, pink-footed, New Zealand and slender-billed shearwaters. California.

faralloni (Kellogg). From Brandt, Baird and Farallon cormorants, red-throated loon. California.

forficulatum (Nitzsch). From California brown pelican. California. (Pelicans, North America, Europe.)

fuliginosum (Taschenberg) (*Lipeurus testaceus* Taschenberg). From black-vented and pink-footed shearwaters. California (Europe).

giganticola (Kellogg) (*Nirmus*, *Lipeurus confidens* Kellogg). From black-footed and short-tailed albatrosses, dark-bodied shearwater. California.

luridum (Nitzsch) (*Lipeurus longipilus* Kellogg, *L. picturatus* Kellogg). From American coot or mud hen. California.

macrocephalum (Kellogg). From Pacific nighthawk. California.

mergi-serrati (De Geer) (*Lipeurus temporalis* Nitzsch). From red-breasted merganser. California (Ducks, Europe.)

modestum (Giebel) (*Lipeurus laculatus* Kellogg and Chapman). From Pomeraine jæger and pink-footed shearwater. Alaska, California.

nigrolimbatum (Giebel) (*Lipeurus varius* Kellogg). From Pacific and Rodgers fulmars. California.

pederiforme (Dufour) (*Lipeurus macilhennyi* Kellogg and Kuwana). From black-footed albatross. Alaska, California.

parviceps (Piaget). From tern and eider duck. Alaska.

perplexum (Kellogg and Chapman). From sooty grouse, California; from Columbian sharp-tailed grouse, Washington.

snodgrassi Kellogg. From rufous humming bird. California.

toxocerum (Nitzsch). From Farallon cormorant, California brown pelican. California.

Giebelia mirabilis Kellogg. From black-vented, dark-bodied, pink-footed, slender-billed and New Zealand shearwaters, short-tailed albatross. California.

Docophoroides brevis (Dufour) (*Eurymetopus*, *Lipeurus taurus* Nitzsch). From short-tailed albatross, Pacific and Rodgers fulmars, California; black-footed albatross, Alaska. (Albatross, Europe, North America.)

CHAPTER XIII

EPHEMERIDA (Order) [1]

(*Ephemeron*, a mayfly)

Mayflies

The mayflies are aquatic insects of medium or small size, complex metamorphosis, biting mouth parts in the larval stage and abortive in the adult. The eggs are laid in the water during the late summer and fall and hatch into frail nymphs or naiads which are characterized by rather long antennæ, three long caudal filaments, and short leaf-like gills along the sides of the body. At rest the abdomen is often curled up over the body in a characteristic attitude. They live at the bottoms of streams, pools, and lakes, feeding upon small aquatic plants, animals, and organic material, and lead a very precarious life, being the chief food of many aquatic insects and fishes. It requires from one to three years for the nymphs to become full-grown, after which they swim or float to the surface of the water or crawl out upon the banks or plants, emerging in the adult stage, fully winged.

The mayflies, shadflies, or lakeflies, as the adults are called, are active, fragile insects which dance about the lights at night and rest quietly on some convenient object during the day. The body is long and slender, with long antennæ and a pair of caudal filaments often much longer than the body. The front wings are large, but delicate, and the hind wings are much reduced, and, rarely, wanting. They average from ½ to 1 inch in length and are usually dull in color. Mayflies are most abundant in regions where the summers are hot and there is an abundance of fresh water. Consequently they are by no means as abundant in the Western States as in the Middle West and Eastern States. Little systematic work has been done on our Western Species and consequently but few are listed here.

List of Western Species

Hexagenia bilineata (Say) [*Baëtis bilineata* (Say)]. Throughout North America.
variabilis Eaton (*H. limbata* Walsh). Common throughout the United States west to New Mexico.
Leptophlebia vaciva Eaton. Oregon, Washington.
memorialis Eaton. California.
gregalis Eaton. Oregon, Washington, California.
pallipes Hagen. Nevada.
rufivenosa Eaton. Oregon.
Blasturus gravastellus Eaton. Montana.
Choroterpes inornata Eaton. New Mexico.

[1] A. E. Eaton, "A Monograph of the *Ephemeridæ*." Part 1. *Trans. Ent. Soc.*, London. 1871, p. 1. Also a "Revisional Monograph of Recent *Ephemeridæ* or Mayflies." *Trans. Linn. Soc.*, London, 2nd ser. 3, *Zoöl.* 1883–1886, 6 parts.
N. Banks, *Trans. Am. Ent. Soc.*, 19, 1892, p. 331; 26, 1900, p. 245.

Ephemera compar Hagen. Colorado.
Ephemerella inermis Eaton. Colorado.
grandis Eaton. Rocky Mountains, Colorado, Wyoming, New Mexico, Alaska.
Baëtis hageni Eaton (*Cloë unicolor* Hagen, renamed). Washington.
Clæon vicinum (Hagen) (*Cloë vicina* Hagen). Washington.
Callibætis californicus Banks. So. California.
americanus Banks. Colorado, Washington (and New Hampshire).
coloradensis Banks. Colorado.
hageni Eaton (*Baëtis tessellata* Hagen, renamed). Washington, British Columbia, Oregon, California, Arizona.
ferrugineus Walsh. Throughout N. America. British Columbia, Washington, Montana, Oregon, California.
undatus (Pictet) (*Cloë undata* Pictet). So. California, Arizona, New Mexico (Texas, Mexico).
pictus Eaton (*Baëtis pictus* Eaton). California.
pallidus Banks. Colorado.
Tricorythus explicatus Eaton. Arizona, Mexico.
Chirotonetes mancus (Eaton) (*Isonychia manca* Eaton). Montana.
Ameletus dissitus Eaton. California.
subnotatus Eaton. Colorado.
exquisitus Eaton. Washington, Oregon.
Siphlurus occidentalis Eaton (*Heptagenia brunnea* Hagen, in part renamed.) Colorado, Washington, Oregon, Nevada, California, Wyoming.
Bætisca obesa Say. (North America), California.
Iron nitidus Eaton. Washington, Oregon, California.
Cinygma integrum Eaton. Washington, Oregon.
par Eaton. Arizona.
mimus Eaton. Colorado.
geminatum Eaton. Washington, Oregon, California.
Rhithrogena hageni Eaton (*Heptagenia brunnea* Hagen, in part renamed.) California, Nevada.
elegantula Eaton. Colorado, Arizona.
Ecdyurus verticis Say. (North America). Washington.
vicarius Walker (*Baëtis vicaria* Walker). Washington (East U. S.).

CHAPTER XIV

ODONATA (Order)[1]

(*Odous*, a tooth)

Dragonflies and Damselflies

The members of this order are large insects with simple or incomplete metamorphosis and well developed biting and chewing mouth parts. The nymphs are entirely aquatic, living at the bottoms of pools, lakes, creeks, and rivers, and are most interesting, though not altogether beautiful creatures (Fig. 80, a, b, c). They are often completely camouflaged to match their immediate surroundings by coloration or by a covering of mud,

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E. M. Walker, "Key to N. A. Species of *Æschna*." *Can. Ent.*, 40, 1908, pp. 377, 450. "The N. A. Dragonflies of the Genus *Æschna*." Univ. Toronto Studies, *Biol. Ser.*, No. 11. Toronto, 1912.

R. A. Muttkowski, *A Catalogue of the Odonata of N. A.* Bul. Pub. Mus. Milwaukee, 1, art. 1, 1910.

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F. Ris, "Libellulinen in Coll. Selys," *Zoöl. Fasc.*, 9–16, pp. 1–1245, 1914.

A. D. Whelan, "Morphology of the Abdomen of *Odonata*." *Trans. Am. Ent. Soc.*, 44, 1918, p. 374.

J. G. Needham very kindly read and corrected the manuscript on this order.

débris, or green algæ. Some species bury the bodies in the sand or mud so that only the eyes protrude. They feed upon all sorts of small aquatic animals including crustaceans, nymphs of mayflies, stoneflies, other dragonflies, tadpoles, young salamanders, fish and so on. The living prey is usually ambushed and captured by the long extensible lower lip or labium which is quickly thrust out like an arm to seize the unsuspecting victim. The labium is folded masklike over the face when not in use. The ungainly nymphs crawl slowly along the bottom or may suddenly dart ahead by sculling with the external leaf-like gills or by forcing water from the rectum. Respiration is by means of the leaf-like external gills at the posterior end, in the case of the damselflies, and by internal rectal gills in the dragonflies. In the latter the water flows into the rectum and it is the sudden forced expulsion of it that shoots the nymph ahead. It requires from three or four months to a year or even four years or over to complete a life cycle. The damselflies may have two or more generations a year, while the dragonflies normally have but one. The winter is usually passed in the nymphal stage, but some adults hibernate. At maturity the nymphs crawl out of the water on plants, rocks, or the shore, and the adults emerge through a slit in the skin of the back. The molted skins are often abundant around the shores of pools and streams.

The adults (Fig. 80, A–E), are among the most wonderful and interesting insects because of their bright colorings, strong swift flight, and remarkable habits. They have long slender bodies with large heads composed mainly of two enormous compound eyes and the mouth parts. There are also three ocelli and short setiform antennæ. The four long membranous wings are strengthened by numerous net-like veins with a nodus or notch near the middle of the front margins. They are either equal in size, as in the damselflies, or the hind pair is slightly wider at the base, as in the dragonflies. In the former case they are held vertically over the body at rest and in the latter they are held horizontally at rest. The accessory genital organs of the male are located on the venter of the second abdominal segment. The damselflies are weak fliers and are usually found near the surface of the water, near the ground, or resting on the low shrubs and grasses, while the dragonflies are strong steady fliers to be found almost everywhere and often at great distances from their breeding places. All are predaceous in habits, feeding largely on mosquitoes, gnats, punkies, and myriads of other insects, as well as on their own weaker relatives, all of which are captured on the wing and greedily devoured. Because of the great numbers of mosquitoes and pestiferous gnats thus destroyed, the dragonflies serve mankind in a most useful way in many of our warm inland valleys where mosquitoes and gnats breed in immense numbers. The adults are known to all the country folk, but often by widely different names as dragonflies, devil's darning needles, mosquito hawks, snake feeders, snake doctors, mule killers, horse stingers, and so forth. Many a boy and girl still believes them to be all the common names imply, while to those who really know them, they are harmless benefactors.

The eggs are laid during the spring and summer months and are inserted into plant tissues by the damselflies and by some dragonflies, and dropped into the water or pushed down into the sand and mud at the shallow bottoms by other dragonflies.

FIG. 80.—Dragonflies and damselflies. A, the magnificent dragonfly, *Macromia magnifica* M'Lachlan; B, the white tail, *Plathemis lydia* (Drury); C, D, E, the ruby-spot damselfly, *Hetœrina americana* (Fabr.); C, same on the wing; D, inserting eggs in a sedge under water; E, at rest; a and b, dragonfly nymphs or naiads; c, damselfly nymph or naiad emerging from the water preparatory to transforming into the adult form.

The *Odonata* are divided into two well defined groups or suborders, the damselflies and the dragonflies. Some differences in their appearance have already been pointed out. They may be further separated as follows:

KEY TO THE SUBORDERS OF ODONATA

1. Adults with both pairs of wings alike and held vertically over the back when at rest. Nymphs with three leaf-like external gills at the posterior end. (Damselflies) **Zygoptera**

2. Adults with the hind pair of wings wider at the base than the fore pair, both pairs held horizontally when at rest. Nymphs without external posterior leaf-like gills. . . . . (Dragonflies) **Anisoptera** p. 146

ZYGOPTERA (Suborder)

Damselflies

The damselflies are much less conspicuous and aggressive than are the larger and more active dragonflies. The nymphs are, however, apparently much more able to hold their own than the more fragile adults and many of them are as large and formidable as those of some dragonflies.

The adults are poor fliers and seem more inclined to rest upon the grasses and shrubs near the water than to venture far in the air. The females are often more sober in color than the males. By means of the sharp ovipositor the eggs are inserted within the tissues of the leaves and stems of grasses, sedges, rushes, and so on, just below the surface of the water. The writer and others have observed the females ovipositing 12 or more inches below the surface, being completely submerged for longer than thirty minutes. Kennedy has noted *Archilestes californica* M'Lachlan laying eggs in small willow limbs overhanging the water from five to eight feet above the surface. There is much yet to be learned about the life histories and habits of these very fascinating insects in the west.

KEY TO FAMILIES

Wings with five or more, usually many, antenodal crossveins. . . . . **Agrionidæ**
Wings with less than five, usually two, antenodal crossveins. . . **Cœnagrionidæ** p. 145

WESTERN SPECIES OF ZYGOPTERA

AGRIONIDÆ. The True Agrionids.

Agrion æquabile (Say) *californicum* Kennedy. Washington, Oregon, Northern California.
yakima (Hagen). Washington.
maculatum Beauvais. **The blackwing.** Throughout the United States. California.
Hetærina americana (Fabr.) (Fig. 80, C, D, E) (*H. californica* Hagen, *H. texana* Walsh, *H. basalis* Hagen). **The ruby spot.** The males have the bases of the wings ruby-red, while in the females they are brownish. Common throughout the United States. California, Arizona, New Mexico, Colorado, Montana.
vulnerata Selys. Arizona (Mexico, So. Am.).

CŒNAGRIONIDÆ. The Stalk-winged Damselflies.

Archilestes californica M'Lachlan (*A. grandis* Rambur. In part). The nymphs of this species are among the largest. California, Oregon, Washington.
Lestes alacer Hagen. Arizona, New Mexico (Texas, Mexico).
congener Hagen. A common species throughout the United States and widely distributed in the west.
disjunctus Selys. Common throughout the United States and the west.
forcipatus Rambur. British Columbia, Colorado (U. S.).
sigma Calvert. New Mexico (Texas Mexico).
stultus Hagen. Common in California.
uncatus Kirby. Common in British Columbia, Washington, Oregon, California, Wyoming, Nevada.
unguiculatus Hagen. Common throughout the Western States west of the Rocky Mountains (U. S.).
Hyponeura lugens (Hagen) (*Hetærina*). California, Arizona, New Mexico (No. Mexico).
Argia agrioides Calvert. California, Arizona, New Mexico (Texas).
emma Kennedy. A common species. Washington, Oregon, California, Nevada.
mæsta (Hagen). Arizona, New Mexico (Texas, No. Mexico).
sedula (Hagen). Arizona, New Mexico (So. U. S., Mexico).
tonto Calvert. Arizona, (Mexico).
violacea (Hagen). Arizona, New Mexico (N. A.).
pallens Calvert. Arizona (Mexico).
vivida Hagen. Common about perennial streams throughout the entire western area, the United States, and Canada.
munda (Calvert). Arizona (Mexico).
plana (Calvert). Arizona (Mexico).
Hesperagrion heterodoxum (Selys). Arizona, New Mexico (No. Mexico).
Oxyagrion rufulum (Hagen). Washington, California, Colorado (N. A., S. A.).
Enallagma anna Williamson. Arizona, Nevada, New Mexico, Wyoming, Oregon.
calverti Morse. Throughout the west from Alaska to Mexico (N. A.).
carunculatum Morse. Common. British Columbia, Washington, Oregon, California, Nevada, Arizona (U. S.).
civile (Hagen). California, Arizona, New Mexico, Wyoming, Colorado (U. S., Mexico).
clausum Morse. Inhabits alkaline ponds. Nevada.
cyathigerum (Charpentier) [*E. annexum* (Hagen)]. Throughout the west. This species occurs in the Northern Hemisphere the world over, exclusive of the tropics.
ebrium (Hagen) Oregon? (Eastern U. S.).
exsulans (Hagen) (*Agrion*). New Mexico (Texas, U. S.).
prævarum (Hagen). California, Nevada, Arizona, New Mexico (U. S., Mexico).
robustum Selys. California.
semicirculare Selys. Pacific Coast (Mexico?).
Telebasis slava (Hagen) (*Agrion, Erythragrion*). California, Nevada, Arizona (Texas, Mexico).
Cœnagrion resolutum (Hagen). Oregon, California (N. A.).
Zoniagrion exclamationis (Selys) (*Cœnagrion*). California.
Amphiagrion saucium (Burmeister) (*Pyrrhosma abbreviatum* Selys). Common throughout the country and the west.
Ischnura barberi Currie. Arizona, New Mexico, Colorado.
cervula Selys. British Columbia, Washington, Oregon, California, Nevada, Arizona, New Mexico (Lower California).
damula Calvert. Arizona, New Mexico, Colorado.
demorsa (Hagen). Montana, Wyoming, Colorado, Arizona, New Mexico (Mexico).
denticollis (Burmeister) (*I. exstriata* Calvert). The smallest western damselfly. Common around ponds and sluggish streams. California, Nevada, Arizona, New Mexico (Mexico).
erratica Calvert. British Columbia, Washington, Oregon, California.
perparva Selys. Common throughout the west.

Ischnura ramburi Selys. California (N. A., Cent. A., S. A.).
credula (Hagen). California (So. U. S.).
verticalis (Say). New Mexico (N. A.).
Celænura gemina Kennedy (*Ischnura?*). California.

ANISOPTERA (Suborder)

Dragonflies

The dragonflies have already been well described under the general discussion of this order and need no further amplification here. They are the large, strong, swift flying forms which are much better known to most persons than the more retiring damselflies, and are, because of their aggressiveness, much more important as beneficial insects in destroying mosquitoes, gnats, and other flies. The eggs are dropped into the water during flight or may be pushed into the sand or mud at the bottom of shallow places or inserted into soft plant tissues by the ovipositor at the tip of the abdomen.

KEY TO FAMILIES

Triangles similar and equally distant from the arculus in both pairs of wings; an oblique brace-vein extending backwards from the inner end of the stigma; labium with a large median lobe not overlapped by lateral lobes which have a movable hook.. **Æschnidæ**
Triangles dissimilar, those of the hind wings much nearer the arculus than those of the forewings; oblique brace-vein wanting; labium with a small median lobe overlapped by large lateral lobes which have no movable hook....**Libellulidæ** p. 148

WESTERN SPECIES OF ANISOPTERA

ÆSCHINIDÆ.

Tanypteryx hageni (Selys) (*Tachopteryx*). Washington, Oregon, California, Nevada.
Cordulegaster diadema Selys. Arizona (No. Mexico).
dorsalis Hagen. A large black dragonfly with bright yellow markings. The eggs are laid in the sand at the bottom along the shallow margins of running streams. The slow short-legged nymphs are often covered with green algæ and may attain a length of 45 mm. According to Kennedy four years are spent in the egg and nymphal stages. Swift streams of the Pacific Coast are commonly inhabited and the nymphs feed upon young trout as well as aquatic insects. It occurs throughout the west from Alaska to Southern California and as far east as the tops of the Cascade and Sierra Nevada Mountains.
Gomphoides obscura (Rambur) (*Progomphus*). Oregon, California, Arizona (U. S., Mexico).
borealis (M'Lachlan). Oregon, California Arizona (So. U. S.).
Negomphoides stigmata (Say) (*Gomphoides*). New Mexico (Texas).
Ophiogomphus arizonicus Kennedy. Arizona.
bison Selys (*O. sequoiarum* Butler). California, Nevada.
montanus (Selys). Montana. Also listed as variety of *O. severus* Hagen.
morrisoni Selys. Washington, Oregon, California, Nevada.
nevadensis Kennedy. California, Nevada.
occidentis Hagen. A common species with green thorax and yellow abdomen with brown markings. The nymphs inhabit swift streams. British Columbia, Washington, Oregon, California, Utah.
californicus Kennedy. California, Oregon.
phaleratus Needham. Oregon.

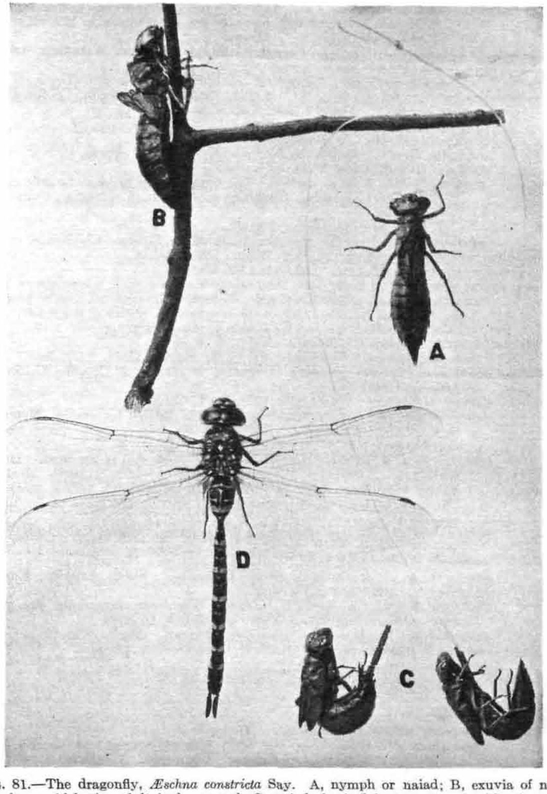

FIG. 81.—The dragonfly, *Æschna constricta* Say. A, nymph or naiad; B, exuvia of naiad from which the adult had emerged; C, naiads hooked in two ways on No. 6 snelled hooks for trout fishing; D, adult. The naiads of this and other dragonflies are excellent bait for trout fishing, particularly in the lakes of the high mountains, where they are an important natural food of trout.

Ophiogomphus severus Hagen. A species resembling *O. occidentis* Hagen. Washington, Oregon, California, Montana, Wyoming, Colorado, New Mexico. It probably has a larger distribution in the west than indicated.

Erpetogomphus compositus Hagen. Oregon, California, Nevada, Wyoming, Arizona (Texas).

designatus Hagen (*Gomphus*). Arizona, New Mexico (Texas, U. S.).

Gomphus confraternus Selys. British Columbia, Washington, Oregon, California.

donneri Kennedy. Donner Lake, California.

externus Hagen. New Mexico (Texas, U. S.).

graslinellus Walsh. Washington (U. S.).

intricatus Hagen. California, Nevada, New Mexico (Texas, U. S.).

militaris Hagen. New Mexico (Texas).

olivaceus Selys. A large species. The nymphs live in large muddy rivers. British Columbia, Washington, Oregon, California, Utah (Nebraska).

nevadensis Kennedy. Nevada.

sobrinus Selys. British Columbia, Washington, Oregon, California.

Dromogomphus spoliatus (Hagen). New Mexico (Texas, U. S.).

Octogomphus specularis (Hagen). California (Mexico).

Anax junius (Drury). A large dark clear-winged species with bright green head and thorax and yellow markings. Common throughout North America, Asia, Hawaiian Islands. One of the commonest species in the west.

walsinghami M'Lachlan (*A. validus* Hagen). So. California.

Gynacantha trifida Rambur. California (N. A., S. A.).

nervosa Rambur. California (So. U. S., Mexico, Cent. A., S. A.).

Æschna californica Calvert. British Columbia, Washington, Oregon, California, Arizona, Utah.

canadensis Walker. Washington (No. U. S., Canada).

clepsydra Say (*A. eremita* Scudder). Alaska, British Columbia, Wyoming, New Mexico (Eastern U. S.). Probably has a much wider western distribution.

constricta Say (*A. palmata* Hagen) (Fig. 81). Common in the west. Alaska, Washington, Oregon, California, Nevada, Colorado (Siberia, Mexico). Adults very large, blue or brown with or without yellow markings. The nymphs form an important diet of trout in the lakes of the higher mountains.

interna Walker. British Columbia, Washington, Oregon, California, Montana, Wyoming, Utah, Arizona, New Mexico.

interrupta Walker *nevadensis* (Walker). California, Nevada.

juncea (Linn.). A common species throughout North America, Europe, Siberia. Abundant in the west.

multicolor Hagen (*A. furcifera* Karsch). Common throughout the entire west. Occurs throughout North and South America.

septentrionalis Burmeister [*A. sitchensis* (Hagen)]. Alaska (Canada).

umbrosa Walker *occidentalis* (Walker). Washington, Oregon.

walkeri Kennedy. California.

Oplonæschna armata (Hagen). Arizona (Mexico, Cent. Am.).

LIBELLULIDÆ

Macromia annulata Hagen. New Mexico, (Texas, U. S.).

magnifica M'Lachlan (Fig. 80, A.). A truly magnificent species, dark with bright yellow markings. Common. Washington, Oregon, California, Nevada, Arizona.

pacifica Hagen. California (Texas, N. A.).

Epicordulia princeps (Hagen) (*Epitheca, Cordulia*). **The water prince.** New Mexico (Texas, U. S.).

Tetragoneuria canis M'Lachlan. Washington, Oregon, California, (U. S., Canada).

spinigera Selys. British Columbia, Washington, Oregon, California (U. S.).

Cordulia shurtleffi Scudder. Common. Alaska, British Columbia, Washington, Oregon, California (U. S., Canada).

Somatochlora albicincta (Burmeister). Alaska (Canada, No. U. S.).
charadræa Williamson. Colorado.
elongata Scudder *minor* (Calvert). Wyoming (U. S.).
forcipata (Scudder). British Columbia (No. U. S., Canada).
semicircularis (Selys). British Columbia, Washington, Oregon, California, Utah, Colorado (U. S., Canada).

Ladona exusta (Say) [*L. julia* (Uhler)]. British Columbia, Washington (U. S.).

Libellula comanche Calvert. Montana, Wyoming, Arizona, New Mexico, California (Texas, Mexico).
composita Hagen. Montana, Wyoming, Nevada.
flavida Rambur. Montana, Wyoming, Colorado, New Mexico (Texas).
forensis Hagen. Common throughout the entire western area.
luctuosa Burmeister (*L. odiosa* Hagen). California, Arizona, New Mexico (Texas, Mexico).
nodisticta Hagen. Common throughout the entire western area (Mexico Cent. A., S. A.).
pulchella Drury. **The ten spot.** The abdomen has a distinct whitish bloom and the wings are spotted. Likely to be confused with the white tail, *Plathemis lydia* (Drury). Common throughout the United States. Washington, Oregon, California, Nevada, Utah (N. A.).
quadrimaculata Linn. A yellow or olivaceous species with dark markings on the wings and body. It often migrates in great numbers. Common throughout the Northern Hemisphere, excepting the tropics. Throughout our western area.
saturata Uhler. The common red species with the basal portions of the wings brownish. Montana, Colorado, Utah, California, Arizona, New Mexico (Mexico).

Plathemis lydia (Drury) [*P. trimaculata* (De Geer)]. (Fig. 80, B.). **The white tail.** Resembles the ten spot, but is smaller. It poises with the wings forward and downward. Only the older males have the white or bluish bloom on the bodies. The young males and the females are brown marked with yellow. It is a common species throughout the United States and Canada, as well as throughout the west.
subornata Hagen. California, Nevada, Utah, Colorado, Arizona, New Mexico (U. S., Mexico).

Œthemis ferruginea (Fabr.). Arizona, New Mexico (N. A., S. A.).

Erythrodiplax funerea (Hagen) (*Trithemis*). California (Mexico, Central Am.).

Erythemis simplicicollis (Say). A common species about pond sand ditches through out the Pacific Coast States from British Columbia to Southern California, including Nevada.
collocata (Hagen). Throughout the west. British Columbia, Washington, Oregon, California, Idaho, Montana, Wyoming, Colorado, Arizona, New Mexico, Utah (Texas).

Pseudoleon superbus (Hagen). California, Arizona (Mexico, Cent. Am.).

Sympetrum atripes (Hagen). (*Diplax*). Colorado.
corruptum (Hagen). A common species inhabiting alkaline, brackish, and fresh water. Throughout the entire western area, as well as North America and Siberia.
costiferum (Hagen). British Columbia, Oregon, Nevada.
illotum (Hagen). Common. British Columbia, Washington, Oregon, California, Montana, Wyoming, Nevada (N. A., Asia).
madidum (Hagen) [*S. flavicostum* (Hagen)]. British Columbia, Washington, Oregon, California, Montana, Wyoming, Colorado.
obtrusum (Hagen) *decisum* (Hagen). British Columbia, Washington, Oregon, California, Colorado.
pallipes (Hagen). British Columbia, Washington, Oregon, California, Colorado, Nevada.
rubicundulum (Say). Wyoming (U. S.).
assimilatum (Uhler). British Columbia, Wyoming.
scoticum (Donovan). British Columbia, Washington, Oregon, California, Nevada, Wyoming (N. A., Europe, Asia).

Sympetrum semicinctum (Say). Throughout the entire western area and many parts of North America.
vicinum (Hagen). British Columbia. Washington (U. S.).
Pachydiplax longipennis (Burmeister) (*Libellula*). Common. British Columbia, Washington, Oregon, Montana, Wyoming, California (N. A.).
Leucorrhinia frigida Hagen. British Columbia (Canada, No. U. S.).
glacialis Hagen. California, Nevada (U. S.).
hudsonica (Selys) (*L. hageni* Calvert). Alaska, British Columbia, the high mountains of California (No. U. S., Canada).
intacta (Hagen). British Columbia, Washington, Oregon, Nevada (U. S.).
proxima Calvert. British Columbia (U. S.).
Dythemis fugax Hagen. New Mexico (Texas).
velox Hagen. California, New Mexico, Arizona (Texas, Mexico, Cent. A., S. A.).
Paltothemis lineatipes Karsch. California, Arizona, New Mexico (Texas, So. U. S., S. A.).
Brechmorhoga mendax (Hagen). California, New Mexico (Texas, Mexico).
Pantala flavescens (Fab.). Cosmopolitan. Occurs throughout the country and the western area.
hymenæa (Say). California, Arizona, New Mexico (N. A., Cent. A., S. A.).
Tramea lacerata Hagen. California, Arizona, New Mexico (U. S., Mexico, Hawaiian Is.)
onusta Hagen. California, Arizona, New Mexico (U. S., Mexico).
Macrodiplax balteata (Hagen) (*Tetragoneuria*). New Mexico (So. U. S.).

CHAPTER XV

NEUROPTERA (Order)[1]

(*Neuron*, a nerve; *pteron*, a wing)

Dobson Flies, Mantispids, Ant Lions, Dusty Wings, Raphidids, Lacewings.

This order originally included nearly all of the insect forms roughly designated as nervewinged, which was a convenient arrangement when the members were little known.

The larvæ are flattened or thysanuriform with the bodies tapering towards both ends or somewhat larger anteriorly; partially hairy or spiny; six legs, and greatly enlarged, often sickle-shaped mandibles, for catching and puncturing the living prey. A few are aquatic, while the great majority are terrestrial and arboreal, and all are predaceous and ferocious in habits and appearance. Because of the benefit derived by the destruction of immense numbers of plant-infesting mites and insects, this order is distinctly beneficial to mankind.

The adults for the most part are rather small and fragile insects, varying in length from one-eighth of an inch to nearly two inches. The wings may be rather strong and leathery as in the dobson flies and mantispids and held flat on the back in repose, or they may be delicate and lace-like and held roof-like over the back as in the case of most of the members. Some of the adults are predaceous, while others appear to take no food at all. They are mostly day fliers, but many are attracted to lights at night.

The order is a small one, and there is yet much life history work to be done in the Western States.

KEY TO FAMILIES

1. Prothorax as long or longer than the mesothorax and metathorax combined.. 2
   Prothorax not so long as the mesothorax and metathorax combined.......... 3
2. Front legs raptorial and greatly enlarged for seizing and holding prey........ **Mantispidæ** *p. 154*
   Front legs not raptorial or greatly enlarged.................**Raphidiidæ** *p. 152*
3. Hind wings narrow at base and not folded like a fan when closed.............. 4
   Hind wings broad at base and with an anal area folded fan-like when at rest.... **Sialidæ** p. 152
4. Wings with numerous veins and without powdery covering.................. 5
   Wings with numerous veins and covered with a whitish powdery covering...... **Coniopterygidæ** p. 164

[1] H. A. Hagen, "Synopsis of *Neuroptera* of North America." *Smithsonian Miscl. Coll.*, 1861.

N. Banks, "Keys to the Families and Genera of *Neuroptera*." *Trans. Am. Ent. Soc.*, 19, 1892, p. 335. "Catalogue of the *Neuropteroid* Insects of U. S." *Am. Ent. Soc. Philadelphia*, 1907.

C. F. Baker, "Neuropteroid Insects." *Invertebrata Pacifica*, 1, 1905, p. 85.

J. F. McClendon, "Venation of *Neuroptera*." *Ent. News*, 18, 1906, p. 116.

5. Antennæ clavate or knobbed 6
Antennæ not enlarged terminally 7

6. Antennæ short . . . . **Myrmeleonidæ** p. 161
Antennæ long . . . . **Ascalaphidæ** p. 163

7. Antennæ not pectinate in either sex; female without exserted ovipositor 8
Antennæ of male pectinate; female with exserted ovipositor . . . . . **Dilaridæ**

8. Radius of fore wings with two or more sectors 9
Radius of fore wings with one radial sector 10

9. Radius of fore wings with two sectors . . . . **Sympherobiidæ** p. 157
Radius of fore wings with three or more sectors . . . . **Hemerobiidæ** p. 155

10. Radial sector of fore wings with definitive accessory veins 11
Radial sector of fore wings without definitive accessory veins, but with marginal accessory veins . . . . **Sisyridæ** p. 155

11. Many of the transverse veins between the costa and subcosta forked 12
None of the transverse veins between the costa and subcosta forked . . . . **Chrysopidæ** p. 158

12. Humeral cross vein recurved and branched; first radio medial cross vein of hind wings longitudinal . . . . **Polystœchotidæ** p. 154
Humeral cross vein not recurved; first radio medial cross vein of hind wings transverse . . . . **Berothidæ** p. 155

SIALIDÆ. Sialids, Alder Flies, Corydalis, and Fish Flies.

The members of this small family are placed in the order *Megaloptera* by some American and European authors and such an arrangement is undoubtedly warranted in a purely systematic work. The insects are the largest of the *Neuroptera* and the larvæ are ferocious aquatic predators which lurk under the stones of rather swift streams and capture everything alive that they are able to overcome. The adults are gray with clouded wings and the males of some species have long horn-like mandibles giving them a most formidable appearance. The most famous member is the Eastern dobson fly, *Corydalis cornuta* (Linn.), which is 75 mm. long to the tips of the folded wings. This species does not appear to occur west of the Rocky Mountains. *Corydalis cognata* Hagen is nearly as large, measuring 60 mm. in length. It is reported from Arizona, New Mexico, and Texas.

The California dobson, *Neohermes californicus* (Walker) (*Chauliodes*), is much the same color as the Eastern dobson, but is only 43 mm. long. It is quite common in the regions of Lake Tahoe and Yosemite valley in the High Sierras of California and Nevada.

Chauliodes filicornis Banks occurs in Arizona; *C. disjunctus* Walker, in British Columbia; and *C. minimus* Davis, in California.

Sialis fuliginosa Pictet is recorded from the Western States; *S. infumata* Newman, from Southern California (U. S.); and *S. nevadensis* Davis (*S. morrisoni* Davis), from Nevada.

RAPHIDIIDÆ.[1] Raphidids, Serpent Flies, Snake Flies.

The members of this interesting family are placed in a separate order, *Raphidioidea* by many modern systematists, but are retained in the *Neu-*

[1] H. Hagen, "Syn. *Neuroptera* N. A." *Smithsonian Miscl. Coll.*, 1861, p. 194.
N. Banks, *Trans. Am. Ent. Soc.*, 37, 1911, p. 339.
The members of this family are placed in the order *Raphidides* by Handlirsch.

roptera here because of the close relationships with the other families. The larvæ are long and flattened with almost black shining head and prothorax of the same width, narrow neck-like mesothorax and metathorax, and wider abdomen which tapers anteriorly and posteriorly and is mottled reddish and grayish in color. The legs are short, but serve to drag the large bodies around effectively. The length varies from one-half to nearly one inch. The young are rather formidable in appearance and are usually found under the bark of forest, ornamental, and fruit trees, where they feed largely on injurious caterpillars and various stages of the bark beetles and other wood-boring insects. The resemblance to certain beetle larvæ has led to much confusion on the part of students as to their identity. Pupation occurs under the bark, the more or less active pupa or nymph never being enclosed in a cocoon. The adults are known as raphidids, serpent flies, or snake flies, and are characterized by having clear, many

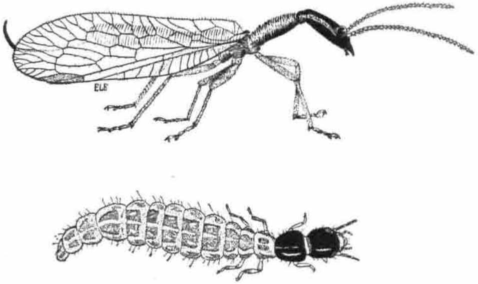

FIG. 82.—The indistinct raphidia, *Raphidia oblita* Hagen. Adult female and larva.

veined wings held roof-like over the back in repose, large flattened head with long slender antennæ, long slender prothorax, and a long tail-like ovipositor in the females. The color consists mostly of shades of brown and dark red with pale abdominal rings. The size varies from 12 to 25 mm. to the tips of the folded wings.

There are two genera, *Raphidia* and *Inocellia*. The former is characterized by having three ocelli while the latter has no ocelli.

The common raphidia, *Raphidia adnixa* Hagen, is rufous or brownish, and from 15 to 22 mm. long. It occurs in Oregon, California, and Nevada.

The large serpent fly, *Raphidia assimilis* Albarda, is 25 mm. long and mostly pale brown, with the head, dorsal posterior spot on the prothorax, and the dorsum of the abdomen black. It is reported in California, Nevada, and British Columbia, and probably inhabits the intervening territory.

The indistinct raphidia, *Raphidia oblita* Hagen (Fig. 82), is a small or medium sized species 15 mm. long and dark brown in color. It is a common form along the coast of Northern California and of Oregon.

The occult raphidia, *Raphidia occulta* Banks, is a rather large, polished dark brown species 15 to 20 mm. long, and common in California, Nevada, Arizona, and New Mexico.

The Arizona serpent fly, *Raphidia arizonica* Banks, has the prothorax mostly black. It occurs in Arizona.

The bicolored serpent fly, *Raphidia bicolor* Albarda, is a common form in California, Nevada, New Mexico, and Colorado.

Raphidia astuta Banks and *R. distincta* Banks are Californian, while the **minute raphidia,** *R. minuta* Banks, occurs in Arizona and New Mexico.

The stigmatic snake fly, *Inocellia inflata* (Hagen) (*Raphidia*), is easily distinguished by the dark body, absence of ocelli, and the prominent short black pterostigmas of the wings. It varies considerably in size ranging from 15 to 23 mm. in length. The western species have been taken in the Lake Tahoe Region of California, and Nevada.

Inocellia hageni Albarda and *I. longicornis* Albarda also occur in California.

MANTISPIDÆ.[1] Mantispids.

This is one of the small families of the *Neuroptera*, the members of which are easily recognized by their mantid-like forms. The chief characteristics are the leathery wings held flat over the body in repose, the short some-

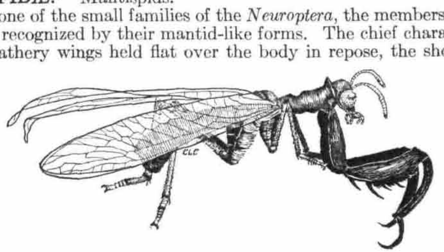

FIG. 83.—The western mantispid, *Climaciella brunnea* Say *occidentis* (Banks).

what clavate antennæ, the long slender prothorax, and particularly the large raptorial front legs for seizing and holding the prey which is eaten alive. The larvæ are known to feed on spiders' eggs.

The adults occur in the grasses during the summer and fall and prey upon living insects and small animals. The life histories of the western species are unknown.

The western mantispid, *Climaciella brunnea* Say *occidentis* (Banks) (*Mantispa*) (Fig. 83), is our commonest species. It is yellow and black or brownish with fuscous wings. The length to the tips of the folded wings averages about 22 mm. The variety occurs in Washington, Oregon, California, Nevada, Colorado, and probably the other States west of the Rocky Mountains. It is replaced in the Eastern and Southern States by the species *C. brunnea* (Say) which differs little from the western form.

Mantispa interrupta Say occurs in New Mexico and the Eastern States. *M. sayi* Banks is southern, inhabiting Arizona, Texas, and Florida. *M. brevicollis* Banks lives in the Sierra mountains of California and Nevada.

Mantispiella pulchella Banks is native of Utah; and *M. scabrosa* Banks is reported from New Mexico.

The marked mantispid, *Symphasis signata* Hagen, somewhat resembles the western mantispid. It occurs in Southern California, Arizona, and New Mexico.

POLYSTŒCHOTIDÆ. The Large Lacewings.

The giant lacewing, *Polystœchotes punctatus* (Fabr.) (*Semblis*, *P. nebulosus* Fabr., *P. irroratus* Say, *P. stictus* Burm., *P. validus* Walk.), is our

[1] H. Hagen, "Syn. Neuroptera N. A." *Smithsonian Miscl. Coll.*, 1861, p. 207.
N. Banks, *Trans. Am. Ent. Soc.*, 24, 1897, p. 23. *Proc. Ent. Soc. Wash.*, 5, 1903, p. 239; 14, 1912, p. 178.

largest neuropterid. The adults are 30 mm. long to the tips of the wings and the expanse from 40 to 75 mm. It is very hairy, blackish, with large broad wings marked with many dark spots and with three longitudinal lines on the prothorax. Very little is known concerning the larval stages of this conspicuous species. It occurs throughout much of North America and is known in British Columbia, Washington, Oregon, California, Arizona, and New Mexico in the west.

BEROTHIDÆ.

Lomamyia texana Banks (*Berotha occidentalis* Banks) is a brown and yellow species from 9–12 mm. long occurring in California, Arizona, Nevada, New Mexico, and Texas.

SISYRIDÆ. Spongilla Flies.

Sisyra vicaria Walker (*S. umbrata* Needham) has the body yellow and brown and the wings brown with an expanse of from 11–13 mm. It is generally distributed throughout the United States east of the Rocky Mountains. In the west it is reported only from British Columbia. The larvæ are parasitic in fresh water sponges.

HEMEROBIIDÆ.[1] Hemerobid Brown Lacewings.

The members of this family differ considerably and there is some confusion as to their proper constitution. In this work the family is used in its broader applications. The larvæ of a few species are aquatic, but by far the great majority are aërial. The adults are in a few species, quite large, larger than any of the *Chrysopidæ*, but for the most part they are small, fragile insects with brown bodies and usually brown mottled and hairy wings which are folded rooflike over the body when at rest. They have a slow irregular flight and are most often observed on dull days or in the dusk of evening and some are attracted to lights at night. The larvæ are predaceous upon many kinds of mites, aphids, and scale insects, and are often important in reducing the numbers of the latter in orchards. The predaceous land forms are much like the chrysopid larvæ, but are usually darker in color, with more slender bodies and smaller head and mandibles. The writer has found them most abundant among the egg masses and young of the scale insects known as mealybugs, wherever they occur outside or in greenhouses. Pupation of the species studied occurs in a thin white silken cocoon. The winter is passed in the larval and pupal stages.

The brown boriomyia, *Boriomyia brunnea* Banks,[2] is straw-yellow without markings. The writer has specimens from Lake Tahoe, California.

The Colorado boriomyia, *Boriomyia coloradensis* (Banks), is yellow and brown with wing expanse 16 to 17 mm. It occurs in California, Arizona, Nevada, Colorado (Alberta).

[1] H. Hagen, "Syn. *Neuroptera*. N. A." *Smithsonian Miscl. Coll.*, 1861, p. 198. "Mon. *Hemerobiidæ* of N. A." *Proc. Boston Soc. Nat. Hist.*, 1889, pp. 250, 276.

N. Banks, *Trans. Am. Ent. Soc.*, 24, 1897, p. 24; 32, 1906, p. 21; 34, 1908, p. 260; 37, 1911, p. 345.

R. P. Currie, *Proc. Ent. Soc. Wash.*, 6, 1904, pp. 79, 81.

J. G. Needham, Buls. 47 N. Y. State Mus., 1901; 86 N. Y. State Mus., July 1905.

Roger C. Smith, "Life Histories and Stages of Some Hemerobiids and Allied Species." *Ann. Ent. Soc. Am.*, 16, p. 129, 1923.

[2] N. Banks, "Syn. of Species of *Boriomyia*." *Trans. Am. Ent. Soc.*, 32, 1906, p. 37.

The dark boriomyia, *Boriomyia disjuncta* (Banks) (*Hemerobius*), is a dark species, the wings clouded with distinct dark markings; 8 mm. long; and a wing expanse of 21 mm. It is found in British Columbia, California, Nevada (Eastern U. S., Canada).

Boriomyia posticata Banks occurs in Utah; *B. prætiosa* Banks, in Colorado; *B. schwarzi* (Banks), in Arizona and New Mexico; and *B. transversus* (Banks), in Arizona and Colorado.

The genus *Hemerobius* is a large one which includes some important members.

The Pacific brown lacewing, *Hemerobius pacificus* Banks [1] (*H. pallescens* Currie), is the best known western species and among the largest, being 10 mm. long. The oval white or pale amber eggs are 0.9 x 0.4 mm. and have a finely reticulated surface. They are laid on the lower sides of the leaves and in the cracks of the bark. The newly hatched larvæ are first pale white, but become darker. After the second molt they are dull amber with dark body markings. The body is then spindle-shaped, 6–8 mm. long, and with 3 jointed antennæ and sucker at the posterior end for anchorage. The third molt occurs at full development within the thin cocoon-like pupa case which is about 5 mm. long. The adults vary from pale to dark brown; black eyes; the wings heavily clouded with brown; the body and wings clothed with short fine hairs. This species has a wide western distribution being known to occur in Alaska, British Columbia, Washington, Oregon, California, Arizona, and New Mexico. The hosts are chiefly red spiders such as the European red mite, the common red spider, two-spotted mite, the six-spotted mite, and others. It has been observed feeding on the rosy apple aphis, green apple aphis, hop aphis, mealy plum aphis, tomato aphis, green peach aphis, cotton aphis, and many other species.

Hemerobius alpestris Banks. Colorado.
- *cockerelli* Banks (*H. caudelli* Currie). Body yellow, wings brownish. British Columbia, New Mexico.
- *conjunctus* Fitch (*H. glacialis* Currie, *H. pinidumus* Fitch, *H. venustus* Banks). British Columbia (U. S.).
- *dorsatus* Banks. Colorado.
- *hesperus* Banks. A brown species, the wings beautifully marked with definite brown spots. Length 8 mm. to tips of wings. Yosemite Valley, California.
- *humuli* Linn. (*H. castanea* Fitch, *H. tutatrix* Fitch, *H. gossypii* Ashmead). A common American species recorded in British Columbia.
- *hyalinatus* Fitch (*H. canadensis* Banks, *H. kootenayensis* Currie). British Columbia (No. U. S.).
- *kokaneeanus* Currie. British Columbia.
- *mæstus* Banks (*H. bistrigatus* Currie, *H. dyari* Currie). A pretty reddish or rusty brown species with the wings clouded towards tips. Length 15–17 mm. A common species in British Columbia, Washington, Oregon, California, Nevada, Colorado, Arizona, New Mexico.
- *nevadensis* Banks. Lake Tahoe Region of California and Nevada.
- *simplex* Banks. Arizona.

Megalomus latus Banks. Arizona, New Mexico.
- *minor* Banks. Lake Tahoe Region of California and Nevada.
- *mæstus* Banks. New Mexico.

The members of the genus *Micromus* are chiefly aphidophagous and are represented in the west by the following species:

[1] N. Banks, *Trans. Am. Ent. Soc.*, 24, 1897, p. 24. Orig. desc.
H. J. Quayle, Bul. 234. Cal. Agr. Exp. Sta., 1912, p. 516.
G. F. Mozenette, *Jour. Ec. Ent.*, 8, 1915, p. 350.

Micromus angulatus Steph. A brown mountain species. Colorado (U. S., Europe).
montanus Hagen. Common in British Columbia, California, Nevada, New Mexico, and probably in other Western States (U. S.).
variolosus Hagen. Washington, California, Arizona, New Mexico, Colorado.

SYMPHEROBIIDÆ. Sympherobid Brown Lacewings.

The genus *Sympherobius*[1] contains a number of species which are effective predators on mealybugs, *Pseudococcus* spp., serious pests to citrus and deciduous trees and vines in California. They also feed on other small insects and on mites.

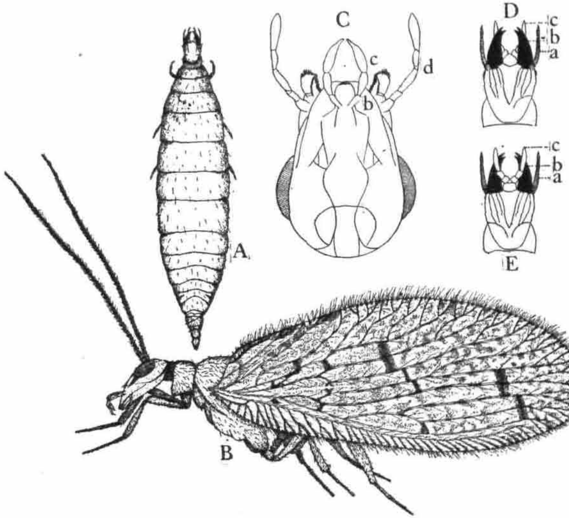

FIG. 84.—The slender brown lacewing, *Sympherobius angustus* (Banks). A, larva; B, adult; C, head of adult; D, E, dorsal and ventral aspects of the head of the larva—a, antennæ; b, mandibles; c, labial palpi; d, maxillary palpi.

The slender brown lacewing, *Sympherobius angustus* (Banks) (*Hemerobius*)[2] (Fig. 84), is perhaps the most beneficial western species. As the common name implies, it is a slender form, brown throughout, although most of the members of the genus are of a similar color. It is a small species averaging 6 mm. in length to the tips of the folded wings. The small

[1] N. Banks, "Key to Species of *Sympherobius*." *Trans. Am. Ent. Soc.*, 37, 1911, p. 345.

[2] N. Banks, *Trans. Am. Ent. Soc.*, 30, 1904, p. 102. Orig. desc.
E. O. Essig, *P. C. Jour. Ent.*, 2, 1910, p. 143.

white eggs are laid singly near the hosts and hatch into spindle-shaped, dull slate-colored larvæ with reddish brown legs and mouth parts. When mature they are from 5 to 6 mm. long. An oval thick white cocoon is formed in which to pupate. There are many generations a year. The larvæ vigorously devour the eggs and young of the citrus, Baker's, the citrophilus, and other mealybugs, and would perhaps be an important natural enemy of these pests were it not for the fact that they are kept well in check by the hymenopterous parasite, *Isodromus iceryæ* Howard, which attacks the larvæ and emerges from the pupæ. The writer has noted from 50% to 80% parasitism in Southern California. The species has been recorded from Southern California, Arizona, and New Mexico.

The California brown lacewing, *Sympherobius californicus* Banks, greatly resembles the slender brown lacewing in appearance and habits. It is abundant in the central and southern parts of California and also occurs in Nevada. It is also parasitized by *Isodromus iceryæ* Howard, and by a pteromalid and a cynipid.[1]

The Arizona brown lacewing, *Sympherobius arizonicus* Banks, occurs in Arizona.

Barber's brown lacewing, *Sympherobius barberi* Banks, is a very small species from 3.5 to 5 mm. long with almost transparent wings. It occurs in California, Nevada, Arizona, and New Mexico, and is a mealybug predator.

Sympherobius bifasciatus Banks. Colorado.

perparvus (M'Lachlan) (*Hemerobius*) is a small species inhabiting Southern California, Arizona, and New Mexico.

pictus (Banks) (*Hemerobius*). A dark form with brown wing bands. Colorado.

umbratus (Banks) (*Hemerobius*). A shining dark brown species with front wings uniformly dark brown and hind wings almost hyaline. It is a small species only 3.5 mm. long. Arizona and New Mexico.

CHRYSOPIDÆ.[2] Green Lacewings, Aphis Lions.

Of all the *Neuroptera* the green lacewings or aphis lions are perhaps the best known because of their striking beauty, abundance, and beneficial habits. The larvæ are flat, thysanuriform, with elongated bodies tapering towards both ends. The head bears a pair of conspicuous double sickle-like jaws which are used to capture, puncture, and extract the body juices of the living prey. The color is yellowish or grayish, mottled with red or brown. When mature the length averages from 6 to 10 mm. and the width is usually about one-fourth the length. Pupation takes place in an exquisite globular white parchment-like cocoon from 2 to 3 mm. in diameter which is hid away in cracks and crevices of or under the bark of trees or in any sheltered place. The adult cuts open a small lid at the top which swings back on a small part acting as a hinge or it may be removed entirely upon emergence. The green lacewings, or golden eyes as some are also called, are beautiful, delicate pale or bright green insects, 15 to 20 mm. long, with the daintiest green lace-like wings. They are common throughout the spring, fall, and summer, and some individuals no doubt hibernate in the warmer regions, although the winter is normally spent in the pupa stage.

The small greenish or pearly white oval eggs 0.5 mm. long are suspended

[1] H. S. Smith, *Monthly Bul.* Cal. State Dept. Agr. 6, 1917, p. 109.

[2] H. Hagen, "Syn. *Neuroptera* of N. A." *Smithsonian Miscl. Coll.*, 1861, p. 210.

N. Banks, "A Revision of the Nearctic *Chrysopidæ*." *Trans. Am. Ent. Soc.*, 29, 1903, p. 137, also 34, 1908, p. 259.

Roger C. Smith, "The Biology of the *Chrysopidæ*." *Memoir* 58, Cornell Univ. Agr. Exp. Sta., June 1922.

in the air on long hair-like stalks which are from 5 to 10 mm. long (Fig. 86). They are attached singly or in large numbers to leaves, small twigs, or to any suitable object, and are always a source of wonder to those who discover them for the first time.

The adults appear in early spring and again in the fall indicating the maximum numbers of adults at these seasons, although breeding appears continuous throughout the summer, there being from five to six generations a year. The adults appear to take no food. The larvæ, however, make up for this deficiency in their parents by an enormous appetite which can be appeased only by from 200 to 400 aphis or similar insects before reach-

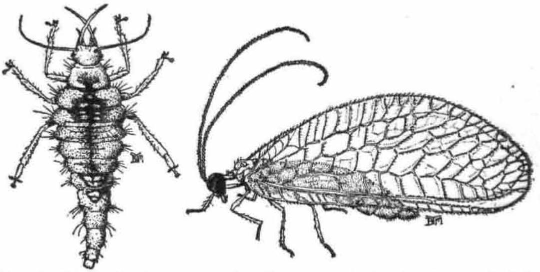

FIG. 85.—The California green lacewing, *Chrysopa californica* Coq. Lava and adult. (After Quayle.)

ing full development. Because of their fondness for aphis they are known by the appropriate name of aphis lions. Besides aphis they also devour with equal satisfaction, orchard mites, thrips, leafhoppers, psyllids, scale insects, small caterpillars, grubs, and like most insect predators are cannibalistic. In other words they stop short of nothing which they can capture and pierce with their wicked jaws. They are on the whole very beneficial and would be more effective if they were not in turn devoured by other predaceous larvæ such as the ladybird beetles and more particularly held in check by certain hymenopterous parasites.

Banks recognizes six genera of which four occur in the west. The genus *Chrysopa* however embraces nearly all of the species most of which are thought to be a single species by students unfamiliar with the family.

The California green lacewing, *Chrysopa californica* Coquillett [1] (Figs. 85, 86), is by far the commonest western species, being to the west what the golden eye or lacewing, *Chrysopa oculata* Say, is to the east. The former meets the latter at the summits of the Rocky Mountains and in New Mexico, although it is best known along the Pacific Coast from Washington to California, and also in Nevada, Arizona, New Mexico, Texas, and Lower California. It is a pale or bright green species with a conspicuous yellow longitudinal stripe on the dorsum. The length varies from 9 to 14 mm.

[1] D. W. Coquillett, *Ann. Rept.*, State Bd. Hort., Cal. 1890, p. 288. Orig. desc.
V. L. Wildermuth, *Jr. Agr. Research*, Washington, D. C., 6, No. 14, July 1916, p. 515.

The dark-lipped lacewing, *Chrysopa rufilabris* Burmeister (*C. repleta* Walk., *C. attenuata* Walk., *C. novæboracensis* Fitch, *C. citri* Ashm.), is smaller than *C. californica* Coq. It occurs in Southern California, Arizona, New Mexico, and in the southern and eastern parts of the United States.

The chlorophane lacewing, *Chrysopa chlorophana* Burmeister (*C. latipennis* Schneider, *C. xanthocephala* Fitch, *C. bipunctata* Fitch, *C. transmarina* Hagen), is much like the eastern, *C. oculata* Say, with shorter black marks under the eyes and green veinlets. It occurs in Oregon, Colorado, Arizona, New Mexico, and in Canada and elsewhere in the United States.

The Colorado green lacewing, *Chrysopa coloradensis* Banks, is often confused with the California green lacewing. It is 14–17 mm. long, and is pale green with pale reddish stripes on the sides of the thorax. The known distribution is Washington, Oregon, California, Colorado, Arizona, and New Mexico.

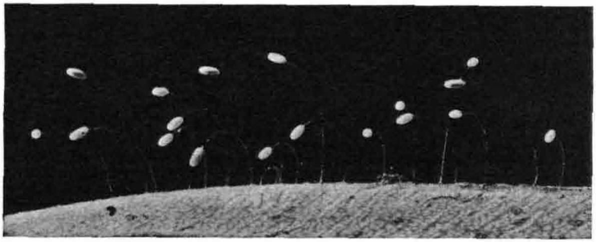

FIG. 86.—Eggs of the California green lacewing, *Chrysopa californica* Coq.

The red-headed lacewing, *Chrysopa majuscula* Banks (*C. erythrocephala* Banks), is a pale yellowish form with reddish head and blackish abdomen. It overlaps with the California and Colorado lacewings in Washington, Arizona, New Mexico, and California.

Other western *Chrysopidæ* are:

Chrysopa arizonensis Banks. An angular red line on the head easily separates it. Arizona and New Mexico.
- *assimilis* Banks. Green, head reddish-yellow, small, black veinlets. Oregon.
- *chi* Fitch. New Mexico (Eastern U. S.).
- *cockerelli* Banks. New Mexico.
- *excepta* Banks. New Mexico.
- *explorata* Hagen. New Mexico.
- *externa* Hagen. Southern California, Arizona, New Mexico.
- *furcata* Banks. California, New Mexico.
- *furculata* Banks. Southern California.
- *gravida* Banks. A large yellowish-green species. Yosemite Valley, California.
- *injusta* Banks (*C. marginalis* Banks). A yellowish-green species 14 mm. long, most of the cross veinlets of the forewings margined brown. Southern California.
- *lineaticornis* Fitch (*C. puncticornis* Fitch). Western States.
- *luctuosa* Banks. New Mexico.
- *nania* Banks. Arizona.
- *nigricornis* Banks (*C. colon* Fitch). Colorado to the Atlantic Ocean.
- *oculata* Say (*C. euryptera* Burm., *C. illepida* Fitch, *C. omikron* Fitch, *C. fulvibucca* Fitch, *C. mississippiensis* Fitch). New Mexico (United States and Canada).
- *placita* Banks. Colorado.
- *pleuralis* Banks. Colorado.

Chrysopa plorabunda Fitch (*C. pseudographa* Fitch, *C. robertsoni* Fitch, *C. illinoiensis* Shimer). Colorado, New Mexico (Eastern U. S.).
schwarzi Banks. Head and thorax red and yellow with dark markings; legs, abdomen and wing veins green. Arizona, New Mexico.
separata Banks. Colorado, New Mexico.
Allochrysa arizonica Banks. Arizona.
Chrysopiella pallida Banks. Pale yellow, New Mexico.
sabulosa (Banks) (*Chrysopa*). Green with black markings, divisory veins of the 3rd cubital black. Arizona, New Mexico, Colorado.
Eremochrysa californica Banks. Brown and reddish with cross veinlets mostly brown. 8 mm. long. California.
fraterna (Banks). Yellowish with brown markings. 12 mm. long. California, Nevada, Colorado, New Mexico.
punctinervis M'Lachlan. Yellowish marked brown and red. 9–11 mm. long. Common in the arid regions of Southern California, Arizona, New Mexico, and Colorado.
Nothochrysa californica Banks. A large dark form with body dark brown, antennæ black and brown veins. Length 12–14 mm. Central Coast Region of California.
Meleoma innovata (Hagen) (*M. mexicana* Banks). New Mexico (Mexico).
pallida Banks. Arizona.
verticalis Banks. Pale green, wing expanse 35–38 mm. British Columbia, Colorado, New Mexico. Will undoubtedly be found in other Western States.

MYRMELEONIDÆ.[1] Ant Lions.

The larvæ known as ant lions are ugly, ferocious looking creatures which lie concealed at the bottoms of exquisitely formed funnel-shaped pits, with only their long sickle-like, toothed jaws extending upwards ready to snap any unfortunate victim which blindly stumbles over the treacherous sliding brink of the sand crater. Because of their roving habits, ants are the common prey, so that the name "ant lions" has become attached to these more alligator-like terrors, which are also known to many boys as doodle bugs. The small pits may be widely scattered or they may occur in such great numbers as to encroach upon each other (Fig. 87). They vary in size with the growth of the young. The larger ones may attain a diameter of 1½ inches and about an equal depth. They are formed by throwing sand with a violent backward snap of the head and jaws during which operation the body is turned around and round at the bottom to give the circular form. This interesting procedure may be witnessed when the ant lions throw sand to confuse and drag down insects struggling on the steep slopes in a vain attempt to escape destruction at the bottom. The larvæ are short

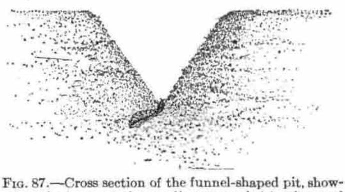

Fig. 87.—Cross section of the funnel-shaped pit, showing the larva of the ant lion concealed in the sand beneath with only the long sickle-shaped jaws or mandibles protruding at the bottom.

[1] H. A. Hagen, "Syn. Neuroptera of N. A." *Smithsonian Miscl. Coll.*, 1861, p. 225.
N. Banks, "Classification of N. A. *Myrmeleonidæ*." *Can. Ent.*, 31, 1899, p. 67. *Trans. Am. Ent. Soc.*, 30, 1904, p. 104.
R. P. Currie, "*Myrmeleonidæ* of Arizona." *Proc. Ent. Soc. Wash.*, 5, 1903, p. 272.

with round plump bodies, narrow head and prothorax, and long piercing mandibles. The length of the body may become 10 mm. or more when full growth is attained (Fig. 88, C). The surface is clothed with long, stiff spine-like hairs which help to anchor the bodies in the sand which is so admirably matched in color. In scooping out the bottoms of the pits one must look carefully to find the larvæ because of the covering of sand particles held by the body hairs and the similarity in coloration. When full grown the larvæ construct rude silken cocoons in the sand and pupate at the bottoms of the pits. The mature insect would never be suspected by the uninitiated of ever having arisen from such a vicious larva, for they are most unassuming, frail, and even delicate insects with long slender bodies, short clubbed or knobbed antennæ, and two pairs of long, thin, delicate, many-veined wings which usually have many or few dark spots (Fig. 88). In flying they have a slow hesitating gait and do not spend much time on the wing. The eggs are deposited directly in the sand and a pit begins to form and grow as soon as they hatch and the larvæ develop.

List of Western Species

Paranthaclisis congener (Hagen) (*Acanthaclisis*). Arizona.
hageni (Banks). Arizona, New Mexico.

Myrmeleon crudelis Walker (*M. rusticus* Hagen). Arizona, New Mexico (U. S., Cent. Am.).
distans Banks. Southern California.
diversus Hagen. Wyoming.
exitialis Walker. California.
immaculatus De Geer. Arizona (U. S.).
occidentalis Currie. Washington, Oregon, California, Utah, Colorado, Arizona, New Mexico (So. U. S.).

Psammoleon guttipes Banks (*P. ingeniosus* Hagen, *P. sinuatus* Currie). Arizona, Colorado.
inscriptus (Hagen). New Mexico (Texas).

Glenurus snowi Banks. Arizona.

Dendroleon obsoletum (Say) (*D. ocellatus* Burm., *D. nigrocinctus* Ramb.). Arizona, (U. S.).
speciosum Banks. Colorado.

Eremoleon macer Hagen. Arizona.

Hesperoleon[1] *abdominalis* (Say) (*Myrmeleon juvencus* Hagen, *M. salvus* Hagen, *Brachynemurus*). Arizona, New Mexico (U. S.).
assimilis (Banks). Oregon, California (U. S.).
blandus (Hagen). Idaho, Nevada, Wyoming, New Mexico.
brunneus (Currie) (*B. centralis* Banks). Arizona, New Mexico, Colorado.
carrizonus (Hagen). Arizona.
coquilletti (Currie) (Fig. 88, B). California, Arizona, New Mexico.
elongatus (Banks). New Mexico.
ferox (Walker) (*B. peregrinus* Hagen). Washington, Oregon, California, Nevada, Arizona, New Mexico, Colorado.
hubbardi (Currie) (*B. cockerelli* Banks, *B. nubeculipennis* Currie). Arizona, New Mexico.
maculosus (Banks). California.
minusculus (Banks). California, Arizona.
niger (Currie). Arizona.
nigrilabris (Hagen). Arizona, New Mexico, Wyoming, Colorado.
pallidus (Banks). Arizona.

[1] N. Banks, "Key to N. A. Species of *Brachynemurus*." *Trans. Am. Ent. Soc.*, 25-1898-9, p. 205.
N. Banks, "The Genus *Brachynemurus*." *Ent. News*, 24, pp. 63–65, 1913.

Hesperoleon papago (Currie). So. California, Arizona.
pulchellus (Banks). California.
quadripunctatus (Currie) (Fig. 88, A). California, Nevada, Arizona.
sackeni (Hagen). So. California, Arizona, New Mexico, Colorado.
singularis (Currie). Arizona.
tenuis (Banks). New Mexico.
texanus (Banks) (*B. intermedius* Currie). Arizona, New Mexico.
tuberculatus (Banks). Arizona, New Mexico (Cent. Am.).
versutus (Walker). Colorado, New Mexico.
yavapai (Currie). Arizona.
Clathroneuria barberi (Currie) (*Brachynemurus, Scotoleon*). Arizona.
delicatulus (Currie). Arizona.
longipalpis (Hagen). California, Nevada, Arizona, New Mexico.
pusillus (Currie). Arizona, New Mexico.
schwarzi (Currie) (*Brachynemurus*). Arizona.
Calinemurus fuscus Banks. Arizona.
Cryptoleon henshawi Hagen (*Maracanda*). Washington, Oregon.
Maracandula bellula Banks (*M. pygmæus* Currie). California, Arizona.

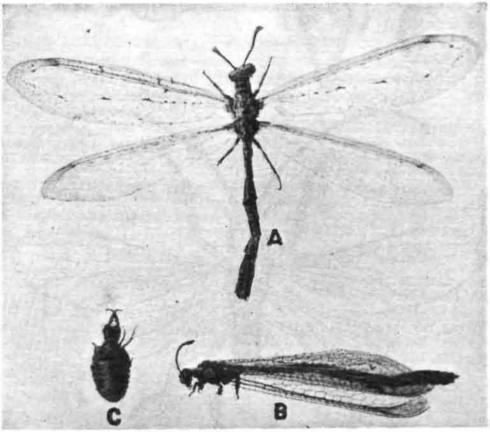

FIG. 88.—Ant lions. A, adult of *Hesperoleon quadripunctatus* (Currie); B, adult of *H. coquilletti* (Currie); C, larva.

ASCALAPHIDÆ.[1] Ascalaphids.

The larvæ resemble those of the ant lions, but lie on the surface or are partly covered with dirt and do not dig a pit.

Neuroptynx furciger M'Lachlan. Arizona.
Ululodes albifrons (Banks) (*Ulula*). Arizona.
arizonensis Banks. Arizona.

[1] H. W. van der Weele, "Ascalaphiden Monographisch Bearbeit." *Coll. Zoöl. du Baron Edm. Lonchamps. Fas.* 8, Bruxelles, 1908.

CONIOPTERYGIDÆ.[1] Dusty Wings, Mealy Wings.

The dusty wings, so called because of the presence of fine powdery wax on the wings, are obscure, mostly minute insects, scarcely more than one-eighth of an inch long. The adults hold the wings roof-like over the bodies when in repose. The larvæ are small, chrysopid-like, and predaceous on

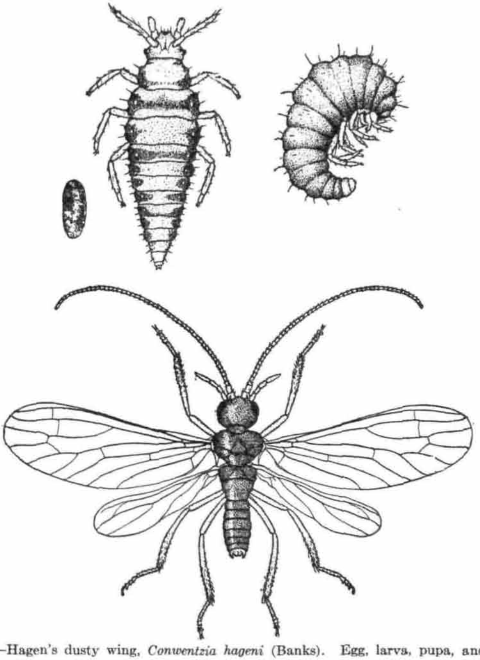

FIG. 89.—Hagen's dusty wing, *Conwentzia hageni* (Banks). Egg, larva, pupa, and adult. (After Quayle.)

small insects and mites. They are often present in sufficient numbers to be a factor in controlling the red spiders in particular. All stages are arboreal in habits and are most often taken from trees and shrubs.

The narrow dusty wing, *Coniopteryx angustus* Banks, is yellow or dark brown with dark abdomen, dark and mealy wings, and 3 mm. long. The

[1] N. Banks, *Proc. Ent. Soc. Washington*, 8, 1906, p. 82.

larvæ feed chiefly on the eggs, young, and adults of the common red spider. The species occurs in Southern California and Arizona.

Hagen's dusty wing, *Conwentzia hageni* Banks [1] (Fig. 89), is by far the most abundant and important member of this family in the west. The eggs are oval, pinkish or yellow, 0.5 mm. long with hexagonal reticulations on the surface. They are laid on the leaves and twigs among the colonies of mites. The larvæ are pale whitish or yellow with reddish, brown, or dark markings on the body, and somewhat resemble small chrysopid larvae. They attain a length of 3 to 4 mm. and are quite active, crawling freely about among the living hosts which are readily devoured. When mature they spin a thin cocoon in which pupation occurs. Hibernating larvæ spin extra heavy cocoons for winter protection. There are several generations during the summer. The adults are mostly brown with black heads and mealy white wings which are fringed with minute cilia on the margins. The length varies from 3.5 to 4 mm. The species is common throughout California and probably has a wide distribution in the west, inasmuch as it is generally found throughout the entire country. It is most abundant during August, September, and November, when the common red spider is also most numerous. The species is valuable as a destroyer of red spiders including many species, chief of which are the common red spider, the two-spotted mite, the yellow mite, and the European red mite.

Fitch's dusty wing, *Malacomyza fitchi* (Banks) (*Coniopteryx*), has the head and thorax brownish and the abdomen yellowish above and reddish beneath; pale legs; light gray wings with long marginal cilia; 2.5 mm. long. It occurs in Colorado and Kansas.

The mealy wing, *Malacomyza farinosa* Banks, greatly resembles Fitch's dusty wing, but has short cilia on the wing margins. It ranges from the San Francisco Bay Region into Southern California.

The dark dusty wing, *Parasemidalis flaviceps* Banks, is 3.6 mm. long and is yellowish with dark mealy wings. It occurs in Southern California.

[1] H. J. Quayle, Bul. 234, Cal. Agr. Exp. Sta., 1912, p. 506.
The genus is also spelled *Conventzia* in error.

CHAPTER XVI

PLECOPTERA (Order)[1]

(*Plecos*, plaited; *pteron*, a wing)

Stoneflies

The members of this widely distributed order are fairly large aquatic insects with simple metamorphosis and primitive biting mouth parts. The adults have four membranous wings, the hind pair in most genera being much larger than the fore pair and folded in plaits over the abdomen when at rest; long tapering many-jointed antennæ; and long many-jointed caudal filaments or cerci, which are, however, much reduced and but one-jointed in the *Nemouridæ*. They are as a rule poor fliers and are usually found resting on the rocks, trees, and plants near the streams in which the larvæ live. The eggs are laid in masses in the water and the dark, depressed larvæ which live under the stones in fresh running streams, have long many-jointed antennæ and caudal setæ much like the adults. Some forms also have three pairs of external gills on the thorax, a pair behind each pair of legs. They are predaceous on other aquatic insects, and when full grown crawl out on stones or on the land for the last molt and transformation to the adult form.

The stoneflies as a whole are of no importance except that the larvæ are a source of food for fishes. The adults of a few species feed upon the buds and leaves of trees and shrubs growing along or near the banks of streams. Three of these occur in the west and are the only species herein described. There are many western species which are listed alphabetically under the families.

The black-winged stonefly, *Tænipoteryx nigripennis* Banks,[2] an entirely black species 9 mm. long, and *T. banksi* Needham and Claassen (*T. pallida*

[1] Nathan Banks, *Trans. Am. Ent. Soc.*, 19, pp. 329–330, 1892; 22, pp. 313–314, 1895, 24, pp. 21–22, 1897; 25, pp. 200–201, 1898–9; 26, pp. 240–245, 1899–1900; 30, pp. 98–99; 1904; 34, pp. 255–257, 1906, 37, pp. 335–337, 1911. *Can. Ent.*, 38, pp. 335–338, 1906; 39, pp. 325–330, 1907. *Psyche*, 12, pp. 55–57, 1905.

Lucy Wright Smith, "Studies in N. A. *Plecoptera*." *Trans. Am. Ent. Soc.*, 43, pp. 433–489, 1917.

J. G. Needham and P. W. Claassen, "N. A. Species of *Acroneuria*." *Can. Ent.*, 54, pp. 249–255, 1922. "Monograph N. A. *Plecoptera*." Thomas Say Foundation, *Ent. Soc. Am.*, 1925.

P. W. Claassen, "New Species of N. A. *Plecoptera*." *Can. Ent.*, 55, pp. 257–263, 281–292, 1923.

C. F. Wu, *Morphology, Anatomy and Ethology of Nemoura.* Bul. Lloyd Library, 23, pp. 1–81, 1923.

The writer is greatly indebted to J. G. Needham and P. W. Claassen for permitting him to review the page proof of their "Monograph of the *Plecoptera* of North America" which was being published by the Say Foundation of the *Entomological Society of America*. This has allowed the incorporation of the proper nomenclature, distribution, keys to families and other information regarding the western species listed.

[2] E. J. Newcomer, *Jour. Agr. Research*, Washington, D. C., 13, p. 41, 1918.

Banks), a brown species 12 mm. long with pale wings, are abundant in Washington, and the former also occurs in Utah and Colorado. The adults of these two species have been observed feeding on the foliage of alder, maple, wild rose, shad bush, thimbleberry, and willow growing along the streams and rivers.

The salmon fly, *Tæniopteryx pacifica* Banks [1] (Fig. 90), is a black species with red and yellow markings and measures 13 mm. to the tips of the

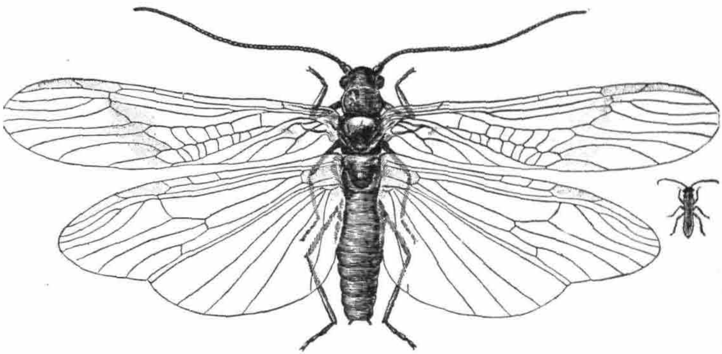

FIG. 90.—The salmon fly, *Tæniopteryx pacifica* Banks. Natural size at right. (After Newcomer, U. S. Dept. Agr.)

folded wings. The adults appear in March and are often present in great numbers on warm days. They have well developed biting mouth parts and do considerable damage by eating holes in the flower buds of fruit trees and injuring the ovaries, causing deformed fruits. Apricots, peaches, and plums have been thus attacked. The adults also feed on the foliage of alder, wild cherry, elm, wild rose, and willow. This species is most injurious along the Columbia River in the Wenatchee Valley and at Pullman, Washington, but is also known to occur in British Columbia, Colorado, and Alberta, Canada, and undoubtedly inhabits the neighboring and intervening states as well.

KEY TO FAMILIES [2]

1. Anal area of the fore wing with two or more full rows of cross veins. **Pteronarcidæ** p. 168
   Anal area of the fore wings either without cross veins, or when present, there is only one row 2

2. With well developed, many-jointed cerci or tails 3
   With one-jointed and much reduced cerci or tails .... **Nemouridæ** p. 169

[1] E. J. Newcomer, *Loc. cit.*, p. 37.
[2] After Needham and Claassen.

3. Fore wings with a series of median and cubital cross veins; radius and media incompletely fused and separating gradually at the base except in small greenish forms .... **Perlidæ**

Fore wings with only one or two median and one cubital cross veins; radius and media completely fused at base and separating at a rather sharp angle. **Capniidæ** p. 169

List of Western Species

PTERONARCIDÆ. The pteronarcids.

Pteronarcella badia (Hagen) (*Pteronarcys*). New Mexico, Arizona, Utah, Wyoming, Montana, Oregon.

regularis (Hagen *Pteronarcys*, *P. triloba* Smith). British Columbia, Washington, Oregon, California, Nevada (Wyoming, Colorado doubtful).

Pteronarcys californica Newport. Throughout the entire region west of the Rocky Mountains from New Mexico to Montana and California to Washington.

princeps Banks (*P. spinosa* Banks). British Columbia, Washington, Oregon, California.

proteus Newman. Oregon, California (Eastern U. S.).

PERLIDÆ. The perlids.

Acroneuria californica Banks. Washington, Oregon, California.

depressa Needham and Claassen. Washington, California.

internata Walker. Colorado (Eastern U. S.).

pacifica Banks. Colorado, Wyoming, Montana, Washington, Oregon, California, Arizona, New Mexico.

pumila Banks. Wyoming, Montana, California (Canada, Texas).

theodora Needham and Claassen. Wyoming, Montana.

Alloperla borealis (Banks) (*Chloroperla*). British Columbia, Washington, Oregon, California, Colorado, Alaska.

coloradensis (Banks) (*Chloroperla*). New Mexico, Colorado, Montana, British Columbia.

continua Banks. California.

fidelis Banks. British Columbia (Canada).

lamba Needham and Claassen. Colorado.

lineosa Banks. Colorado.

pacifica (Banks) (*Chloroperla*). British Columbia, Washington, Oregon, California.

pallidula (Banks) (*Chloroperla*). New Mexico, Arizona, Colorado, Wyoming, Washington, British Columbia, California (Canada).

pilosa Needham and Claassen. Colorado.

serrata Needham and Claassen. British Columbia.

signata (Banks) (*Chloroperla*). New Mexico, Colorado, Washington.

spatulata Needham and Claassen. California.

Clioperla ebria (Hagen) (*Perla*). New Mexico, Colorado, Montana, Oregon, Washington, British Columbia.

gravitans Needham and Claassen. Washington.

marmorata Needham and Claassen. Nevada.

sobria (Hagen) (*Perla*). Pacific Slope.

Isoperla 5-punctata (Banks) (*Chloroperla*). New Mexico.

marmona Banks. Utah.

sordida (Banks) (*Perla*). California, Washington.

Isogenus colubrinus Hagen. Idaho, Washington, Oregon (Eastern U. S.).

elongatus Hagen. Colorado, Montana.

frontalis Newman (*Perla incesta* Banks, *P. titusi* Banks). Idaho (Northeastern U. S.).

Kathroperla perdita Banks. British Columbia, California.

Paraperla frontalis (Banks) (*Perlinella*). New Mexico, Utah, Colorado, Montana, California.

Peltoperla brevis Banks. British Columbia, Washington, Oregon, California.

cora Needham and Smith. California, Nevada.

thyra Needham and Smith. Nevada.

Perla alameda Needham and Claassen. California.
expansa Banks. Colorado.
languida Needham and Claassen. Wyoming, Montana.
luctuosa Banks. California, Oregon.
modesta Banks. Nevada, Colorado.
nona Needham and Claassen. Oregon.
obscura Needham and Claassen. Oregon.
phalerata (Smith). New Mexico, Colorado.
sabulosa Banks. Washington.
sorpta Needham and Claassen. California.
venosa Needham and Claassen. California.
Perlodes americana (Klapalek) (*Arcynopteryx*). Colorado, Utah, Wyoming, Montana, British Columbia.
aurea (Smith) (*Arcynopteryx*). California.
bradleyi (Smith) (*Protarcys*). British Columbia.
irregularis (Banks) (*Dictyopteryx*). Washington.
signata (Hagen) (*Dictyopteryx*). Colorado, Wyoming, Utah, California, Oregon, British Columbia.
tibialis Banks. Washington.
vagans (Smith) (*Arcynopteryx*). California.
yosemite Needham and Claassen. California.

NEMOURIDÆ. The nemourids.
Leuctra augusta Banks. British Columbia.
glabra Claassen. California.
infuscata Claassen. California, Washington.
occidentalis Banks. California, Nevada, Washington (Alberta).
Nemoura biloba Claassen. California.
californica Claassen. California, Washington, Montana, British Columbia.
cinctipes Banks. California, Washington, Colorado, British Columbia, Alaska (Alberta).
coloradensis Banks. Colorado, New Mexico.
cornuta Claassen. California, British Columbia.
delicatula Claassen. Colorado.
depressa Banks. California, Oregon, British Columbia.
flexura Claassen. Colorado.
frigida Claassen. Alaska.
glabra Claassen. Utah, Colorado (Nova Scotia).
interrupta Claassen. Washington.
nevadensis Claassen. California, Nevada, Washington.
oregonensis Claassen. Oregon.
venusta Banks. Arizona, Colorado.
Perlomyia collaris Banks. British Columbia.
utahensis Needham and Claassen. Utah.
Tæniopteryx banksi Needham and Claassen (*T. pallida* Banks). Washington.
californica Needham and Claassen. California.
grinnelli Banks. California.
nigripennis Banks. Colorado, Utah, Washington.
occidentalis Banks. Colorado, Washington, British Columbia.
oregonensis Needham and Claassen. Oregon.
pacifica Banks. Colorado, Washington (Alberta).
pallida (Banks) (*Nemoura*). Colorado.

CAPNIIDÆ. The capnids.
Capnia californica Claassen. California.
elongata Claassen. California.
excavata Claassen. California.
fibula Claassen. New Mexico.
glabra Claassen. California.
grandis (Banks) (*Arsapina*). British Columbia.
nana Claassen. British Columbia.
teresa Claassen. California.
tumida Claassen. California.

CHAPTER XVII

MECOPTERA (Order)[1]

(*Mecos*, length; *pteron*, a wing)

Scorpion Flies

The adults of this order are of medium size and have biting mouth parts and complete or complex metamorphosis. They are apterous or winged with long slender bodies, the males having large caudal pincer-like organs resembling the sting of a scorpion which gives rise to the common name scorpion flies. The head is prolonged into a form like a beak and the legs are long and slender so that some forms greatly resemble crane flies of the dipterous family *Tipulidæ*. The winged species have two pairs of rather long slender many-veined wings which are folded flat over the body when at rest. The larvæ are caterpillar-like in shape with six true legs and eight prolegs. They live in or on the surface of the soil in damp places. Both the adult and larval stages are predaceous on small ground animals. The order is a small one with few Western representatives.

KEY TO THE FAMILIES

1. With 3 ocelli 2
   Without ocelli 3

2. Tarsi with 2 claws .... **Panorpidæ**
   Tarsi with 1 claw .... **Bittacusidæ**

3. Wings well developed .... **Meropidæ**
   Wingless or with very short or abortive wings .... **Boreidæ** p. 171

PANORPIDÆ. Panorpids.

There appears to be no species of the genus *Panorpa* recorded west of the Rocky Mountains.

The Oregon panorpid, *Panorpodes oregonensis* M'Lachlan,[2] differs from *Panorpa* in having a short triangular rostrum and simple tarsal claws. It is a very small species measuring from 7 to 8 mm. in length. The females are unknown. The species is reported only from Oregon.

BITTACUSIDÆ. Scorpion Flies.

The wingless scorpion fly, *Bittacus apterus* M'Lachlan (Fig. 91), greatly resembles a wingless crane fly. The body of the female averages nearly an inch in length. The males are somewhat smaller with the tip of the

[1] H. Hagen, "Syn. *Neuroptera* of N. A." *Smithsonian Miscl. Coll.*, 1861, p. 240.
J. S. Hine, "Review of *Panorpidæ* of America North of Mexico." *Bul. Sci. Lab.*, Denison Univ. 2, pp. 241–264, 1901.
N. Banks, "U. S. Species of *Panorpa*." *Trans. Am. Ent. Soc.*, 22, 1895, p. 315; 37, 1911, p. 350.

[2] *Entomological Mo. Mag.*, 18, 37, 1881. Orig. desc.

abdomen slightly enlarged. They have long, slender legs securely joined to the body, which terminate in a single claw. The color is tan, dark brown, or dull olive green. The species is common in the San Francisco Bay Region and may be found on dull cloudy days crawling through and over the grass during the spring and summer months in search of food which consists of crane flies and various other insects.

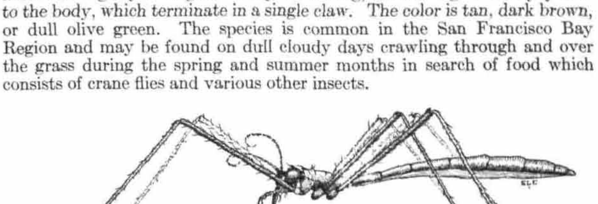

FIG. 91.—The wingless scorpion fly, *Bittacus apterus* M'Lachlan.

The green stigma, *Bittacus chlorostigma* M'Lachlan,[1] is characterized by the shining brownish body and the conspicuous pale green pterostigma of the wings. It varies from 25 to 26 mm. in length and has a wing expanse of 51–57 mm., the greatest expanse of all the species. The females are unknown. It occurs in Southern California.

The Arizona panorpid, *Bittacus arizonensis* Banks, occurs in Arizona.

BOREIDÆ. Boreids.

The California boreid, *Boreus californicus* Packard,[2] is a small black species in which the wings of the male are only half as long as the abdomen. The species occurs along the Pacific Coast, but is most abundant in Washington and British Columbia where it appears on the surface of the snow in February, at which time mating occurs.

Boreus unicolor Hine is a Montana species.

[1] *Loc. cit.*, p. 36. Orig. desc.
[2] J. W. Cockle, On Mating Habits. *Can. Ent.*, 40, 1908, p. 101.

CHAPTER XVIII

TRICHOPTERA (Order)[1]

(*Trix*, a hair; *pteron*, a wing)

Caddice Flies, Caddis Flies, Case Flies

The members of the order *Trichoptera* are small or medium sized insects with complete or complex metamorphosis and biting mouth parts. The larvæ are aquatic, while the aërial adults live in the immediate vicinity of the breeding places.

The adults are known as caddis flies, caddice flies, or case flies, and are mostly sober in color ranging from tan, brown, or gray to smoky black and from ¼–1 inch in length. They are characterized by having abortive biting mouth parts, long slender antennæ, no cerci, and two pairs of somewhat leathery membranous wings, the front pair somewhat narrower than the hind pair and held roof-like over the body at rest. There are many longitudinal and few cross veins in the wings, which, with the body, are densely covered with hairs or hair-like scales, which are the chief distinguishing features. They are not active fliers and are usually to be found resting during the day upon objects near the water, but at night they are on the wing and often gather in large nembers about lights. These strange insects are thought by many to be more closely related to the *Lepidoptera* than to the *Neuroptera*, so that their position here is for convenience of reference only.

The larvæ are the most interesting and are known as case worms, caddis worms, or to many country boys as fish bait. They inhabit the bottoms of ponds, lakes, creeks, and rivers, and are caterpillar-like in form with a soft cylindrical body with chitinized head, thorax, and strong, well-developed legs. The most important thing about these ugly creatures is the manner in which they protect their tender bodies from the cunning trout and other

[1] H. Hagen, "Syn. *Neuroptera* of N. A." *Smithsonian Misc. Coll.*, p. 249, 1861.

N. Banks, Descriptions, Notes, Keys, etc. *Trans. Am. Ent. Soc.*, 19, p. 338, 1892, 24, p. 27, 1897; 25, p. 206, 1898–9; 26, p. 253, 1900; 30, p. 107, 1904; 32, p. 9, 1906; 34, p. 262, 1908; 37, p. 350, 1911. *Jr. N. Y. Ent. Soc.*, 11, p. 241, 1903. *Alaska Harriman Exped.*, 8, pt. 1, p. 159, 1904. *Proc. Ent. Soc. Wash.*, 6, pp. 140, 201, 1904; 8, p. 117, 1906, "Catalogue Neuropteroid Ins. U. S.," *Am. Ent. Soc. Philad.*, p. 34, 1907. *Can. Ent.*, 46, pp. 149, 201, 252, 261, 1914.

G. Ulmer, "*Trichoptera*." *Genera Insectorum*, p. 60, 1907.

C. T. Vorhies, "Studies on the *Trichoptera* of Wisconsin." *Trans. Wisc. Acad. Sci., Arts, Letters*, 16, pt. 1, p. 647, 1909.

Annie L. Hill-Griffin, "Oregon *Trichoptera*." *Ent. News*, 23, p. 17, 1912.

J. G. Needham, In *Fresh Water Biology* by H. B. Ward and G. C. Whipple, John Wiley and Sons, N. Y., pp. 936–937, 1918.

J. T. Lloyd, "Biol. N. A. Caddis Fly Larvæ." *Bul. Lloyd Library, Ent. Ser.*, No. 1, Cincinnati, Ohio, Feb. 1921.

Through the kindness of J. G. Needham the original manuscript on this order was read and corrected by C. K. Sibley who also referred a number of species to the proper families.

fish which are exceedingly fond of them. This is accomplished by spinning a silken tube to fit the body, closing the posterior end, and camouflaging and protecting the exterior by webbing together and incorporating small pebbles, shells, sticks, and other objects common to the bottoms which they frequent (Fig. 92). Some species construct very simple cases on the sides of stones, others make very elaborate ones from small shells, sticks, and so forth, while still others burrow into bits of wood which are just the right size. Those building the movable cases attach themselves by means of two posterior proleg-like organs at the closed end and allow only the armored head, thorax, and legs to protrude when feeding or dragging their abode about, and withdraw entirely into the same at will. Thus it is that one often sees small bits of sticks and peculiar forms of pebbles, leaves, and other shapeless objects moving about on the bottoms of streams in a slow jerky fashion, and then suddenly disappear altogether with the current. Species which build stationary houses on rocks often leave the dwelling and wander short distances. They are carnivorous and their food is thought to be captured in numerous small netlike webs which are suspended on the rocks near their cases. The larvæ of most species are herbivorous and feed upon the decayed vegetation in the water.

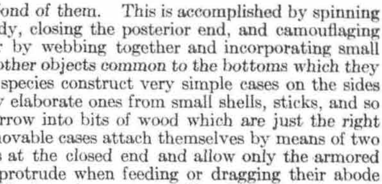

FIG. 92.—A caddice fly larva within its pebble and silken case. When removed it makes excellent trout bait. During dry years of low water when food is scarce trout will swallow the larva, case and all, and large numbers of the cases have been taken from the alimentary canal of trout caught in the mountain rivers.

To the country lad, the caddis worms are an ever available source of fish bait always ready to be had in the quiet eddy in the stream where there is a smooth bottom and an accumulation of dead leaves. Or in the absence of such eddy and smooth bottom, he may be forced to search more diligently among the rocks to secure them. At any rate, he soon has a quantity all done up in individual packages which will keep fresh for several days, and as he needs them the case is partially removed so as to expose the head and the crouching victim is pulled forth to repose on the hook in quite a natural position with the head at the point. If there are any trout or game fish in the stream, this choicest of morsels will not fail to lure them from under the rocks when all man-made baits have failed, especially on the ripples or in swift running water, just where the fish might expect to find an unfortunate separated from his home.

When full grown the larva closes its case for pupation and the adult either emerges directly from the bottom, or the pupa case is dragged to the shore before the adult escapes. It is not unusual to find great numbers of the empty cases in the shallow water along the edges of our western streams.

The eggs are laid in the water on stones, sticks, and aquatic plants in the

spring, summer, and fall. The winter is usually spent in the larval stage. Little or nothing is known concerning the life histories and habits of our western species.

KEY TO FAMILIES

(Adapted from J. G. Needham and J. H. Comstock)

Adults

1. Very small; hairy moth-like; fore wings with numerous erect clavate hairs, marginal fringe longer than the greatest width; antennæ not longer than fore wings .... **Hydroptilidæ** p. 178
   Medium to large; wings broad, marginal fringes not so long as the greatest width; antennæ longer than fore wings 2

2. Maxillary palpi 5-jointed 3
   Maxillary palpi with less than five joints 14

3. Last joint of maxillary palpi simple and not longer than the other joints 4
   Last joint of the maxillary palpi twisted and imperfectly segmented, usually much longer than the other joints 11

4. Ocelli present 5
   Ocelli absent 7

5. Front tibiæ with two or three spurs; middle tibiæ with four spurs 6
   Front tibiæ with one spur or with none; middle tibiæ with two or three spurs .... **Limnophilidæ** p. 175

6. The first two joints of the maxillary palpi short and thick, the third joint much longer and thinner .... **Rhyacophilidæ** p. 176
   The second joint of the maxillary palpi much longer than the first **Phryganeidæ** p. 175

7. Principal fork of the median vein in the fore wings without a closed cell 8
   Principal fork of the median vein in the fore wings with a closed cell .... **Calamoceratidæ** p. 177

8. Closed cell in the first fork of the radial sector of the fore wings 9
   No closed cell in the first fork of the radial sector .... **Molannidæ**

9. Both branches of the radial sector forked 10
   Only the anterior branch of the radial sector forked .... **Leptoceridæ** p. 177

10. Veins R_1 and R_2 in the fore wings confluent apically or connected by an apical cross vein .... **Odontoceridæ** p. 177
    Veins R_1 and R_2 in the fore wings not connected apically .... **Sericostomatidæ** p. 177

11. Ocelli present .... **Philopotamidæ** p. 177
    Ocelli absent 12

12. Front tibiæ with three spurs .... **Polycentropidæ** p. 178
    Front tibiæ with less than three spurs 13

13. Anterior branch of radial sector in fore wings forked .... **Hydropsychidæ** p. 177
    Anterior branch of the radial sector in fore wings not forked .... **Psychomyidæ** p. 178

14. Maxillary palpi with four joints .... **Phryganeidæ** p. 175
    Maxillary palpi with two or three joints 15

15. Maxillary palpi filiform and smooth joints; front tibiæ with a single spur .... **Limnophilidæ** p. 175
    Maxillary palpi hairy or scaly; fore tibiæ with two spurs .... **Sericostomatidæ** p. 177

Larvæ

(Adapted from J. T. Lloyd and J. H. Comstock)

1. Anal prolegs not fused in median line to form an apparent tenth abdominal segment........ 2
   Anal prolegs fused in median line to form an apparent tenth abdominal segment 7
2. Abdomen much wider than thorax........ **Hydroptilidæ** p. 178
   Abdomen little wider than thorax........ 3
3. Dorsum of ninth abdominal segment with a chitinous shield.. **Rhyacophilidæ** p. 176
   Dorsum of ninth abdominal segment without a chitinous shield........ 4
4. Tracheal gills present........ **Hydropsychidæ** p. 177
   Tracheal gills absent........ 5
5. Labrum wholly membranous, white........ **Philopotamidæ** p. 177
   Labrum wholly chitinized........ 6
6. Frons normal........ **Psychomyidæ** p. 178
   Frons long, extending to caudal margin of head........ **Polycentropidæ** p. 178
7. Dorsal surface of labrum with a row of twenty or more stout bristles........ **Calamoceratidæ** p. 177
   Dorsal surface of labrum without these stout bristles........ 8
8. Labrum much longer than broad........ **Odontoceridæ** p. 177
   Labrum broader than long........ 9
9. Metanotum with three pairs of chitinized plates........ **Limnophilidæ** p. 175
   Metanotum without chitinized plates (present in most **Sericostomatidæ**)........ 10
10. Mesonotum soft or with a pair of minute chitinized plates... **Phryganeidæ** p. 175
    Mesonotum wholly chitinized........ 11
11. Femur of hind legs apparently divided with two segments ... **Leptoceridæ** p. 177
    Femur of hind legs not divided........ 12
12. Larval cases made of fine grains of sand and with an extension on each side and a dorsal head........ **Molannidæ**
    Larval cases variable, not as above........ **Sericostomatidæ** p. 177

WESTERN SPECIES OF TRICHOPTERA

PHRYGANEIDÆ.

Phryganea californica Banks. California.
Neuronia lapponica Hagen. Alaska (Northern Europe and Siberia).

LIMNOPHILIDÆ. (*Limnephilidæ*)

Grammotaulius betteni Hill-Griffin. Oregon.
Limnophilus abbreviatus Banks (*Limnephilus*). Colorado.
æqualis Banks. British Columbia.
americanus Banks. Idaho (Northern United States).
cockerelli Banks. New Mexico.
coloradensis Banks (*Goniotaulius*). Colorado.
concolor Banks. Washington.
consimilis Banks (*consimilus*). Colorado.
gravidus Hagen. Alaska, Washington, California.
harrimani Banks. Alaska.
kincaidi Banks. St. George, Idaho, Alaska.

Limnophilus luteolus Banks. Washington.
nebulosus Kirby. Alaska, British Columbia.
ornatus Banks. Alaska (U. S., Canada).
oslari Banks. Colorado.
perjurus Hagen. Alaska.
productus Banks. Utah.
radiatus Say. Washington.
rohweri Banks. Colorado.
secludens Banks. British Columbia (Canada).
sitchensis Kolenati (*L. pacificus* Banks). Alaska, Washington, Oregon.
spinatus Banks. Utah.
vastus Hagen. Alaska.
Anabolina diversa Banks. Arizona, New Mexico, Colorado.
Anabolia assimilis Banks. Arizona.
brevipennis Banks (*Stenophylax*). Colorado.
decepta Banks. Washington.
nigricula Banks. Colorado.
simplex Banks (*Asynarchus*). Alaska.
Glyphopsyche bellus (Banks) (*Glyphotælius*). British Columbia, Washington.
irrorata Fabr. (*G. bryanti* Banks). British Columbia.
Asynarchus costalis Banks. New Mexico.
flavicollis Banks. Alaska (Canada).
fumosus Banks. Alaska, Washington.
pacificus Banks. Washington.
Halesus formosus Banks. Arizona, New Mexico, Colorado.
magnificus Banks. Washington.
Dicosmæcus atripes Hagen. New Mexico.
gilvipes (Hagen). British Columbia, Colorado.
grandis Ulmer. Washington.
tristis Banks. Colorado.
unicolor Banks. Washington.
Stenophylax antennatus Banks. Washington.
hesperus Banks. British Columbia.
minusculus Banks. Washington.
Allophylax punctatissimus (Walker) (*Halesus, Asynarchus*). Alaska (U. S., Canada).
Platyphylax designata (Walker). Alaska, British Columbia, Washington, Oregon, California, New Mexico, Colorado (Canada).
subfasciata (Say). Northwest Ty. (East U. S.).
Homophylax flavipennis Banks. Colorado.
nevadensis Banks. Nevada.
Parachiona centralis Banks (*Asynarchus*). Colorado.
pallidus Banks. Colorado.
pilosa Banks. Washington.
signatus Banks. Idaho.
Phryganomyia alascensis Banks (*Asynarchus*). Alaska.
Ecclisomyia conspersa Banks. Washington.
maculosa Banks. Colorado.
Halesochila taylori (Banks). British Columbia.
Chilostigma alascensis (Banks) (*Halesus*). Alaska.
Oligophlebodes minutus (Banks) (*Halesus*). Colorado, New Mexico.
Psilopteryx brevipennis Banks. New Mexico.
Apatania tripunctata Banks. Alaska, British Columbia, Washington.
Anisogamus disjunctus Banks. British Columbia.

RHYACOPHILIDÆ.

Atopsyche tripunctata Banks. Arizona.
Rhyacophila acropedes Banks. Utah.
angelita Banks. California.
basalis Banks. California.
bifila Banks. British Columbia.
brunnea Banks. New Mexico.
· *coloradensis* Banks (*R. stigmatica* Banks). Colorado, New Mexico.

Rhyacophila grandis Banks. British Columbia.
hyalinata Banks. Colorado.
pacifica Banks. Washington.
Glossosoma alascensis Banks. Alaska.
parvula Banks. New Mexico.
penitus Banks. British Columbia.
ventralis Banks. New Mexico.
Agapetus celatus M'Lachlan. California.
malleatus Banks. California.

PHILOPOTAMIDÆ.

Chimarrha angustipennis Banks. Arizona

SERICOSTOMATIDÆ.

Schizopelex hesperus Banks. Utah.
Notidobia assimilis Banks. California.
griseola M'Lachlan. California.
nigricula M'Lachlan. California.
Brachycentrus occidentalis Banks. British Columbia.
similis Banks. Colorado.
Micrasema scissum M'Lachlan. Alaska.
Heliocopsyche arizonensis Banks. Arizona.
californica Banks. California.
Mormomyia unicolor Banks. California.
Lepidostoma cinereus (Banks). California.
stigma Banks. Colorado.
Thremma deceptiva Banks. New Mexico.

CALAMOCERATIDÆ.

Notiomyia mexicana Banks. Arizona (Mexico).
Heteroplectron californicum M'Lachlan. Alaska, California.
Aniscentropus fuscus Banks. Arizona.

ODONTOCERIDÆ.

Nerophilus californicus (Hagen) (*N. oregonensis* Banks). California, Oregon.
plutonis (Banks) (*Namamyia*). California.

LEPTOCERIDÆ.

Triænodes frontalis Banks. Colorado.
grisea Banks. Colorado.
Leptocella coloradensis Banks. Colorado.
exilis Banks (*L. gracilis* Banks). New Mexico, Colorado.
minuta Banks. Washington, Arizona.
Œcetina inornata Banks. Arizona.
Mystacides alafimbriata Hill-Griffin. Oregon.
nigra (Linn.). Alaska, British Columbia, Washington (Canada, Europe).

HYDROPSYCHIDÆ.

Arctopsyche grandis Banks. Colorado.
Hydropsyche bifida (Banks). British Columbia, Washington, Colorado.
californica Banks. California.
cockerelli Banks. New Mexico, Colorado.
gracilis Banks. Colorado.
novamexicana Banks. New Mexico.
occidentalis Banks. British Columbia, Washington.
oslari (Banks). British Columbia, Colorado.
partita Banks. California, New Mexico, Utah.
scalaris Hagen. New Mexico (United States, Canada).
Rhyacohylax signata (Banks) (*Pellopsyche*). Colorado.
Diplectrona californica Banks. California.
nigripennis Banks. California.

POLYCENTROPIDÆ.

Polycentropus arizonensis Banks. Arizona.
dispar Banks. Arizona.
remotus Banks. British Columbia.
variegatus Banks. Washington.
Holocentropus orotus Banks. Colorado.
Nyctiophylax mæstus Banks. British Columbia.

PSYCHOMYIDÆ.

Psychomyia mæsta Banks. Colorado.
pulchella Banks. Colorado.
Tinodes consueta M'Lachlan. California.

HYDROPTILIDÆ. Microcaddice Flies.

Allotrichia flavida Banks. Colorado.

CHAPTER XIX

THYSANOPTERA (Order)[1]

(*Thysanus*, a tassel; *pteron*, a wing)

Thrips

The thrips are very small, slender insects, many of them scarcely more than visible to the unaided eye, while others are readily discernible. The transformations are for the most part simple or incomplete but in a few species there is an approach to the complex or complete type. The mouth parts are cone-shaped, situated far back on the underside almost to the front legs, and are for piercing and sucking. The effect of their feeding is the destruction of the epidermal cells and a whitening accompanied by total destruction, or withering and scabbing of the outer surface. The wings may be rarely wanting or abortive but usually there are two pairs present, which are long and narrow with few or no veins and an outer marginal row of long hairs which gives rise to the name tassel- or fringed-wing, applied to the order. At rest the wings are folded flat over the back, the marginal hairs usually closing tightly against them.

The antennæ are short and made up of a varying number of segments. The legs terminate in one- or two-jointed tarsi, the latter being most common, and at the end there is an inflatable membranous sac or bladder which is characteristic of the order.

Thrips feed largely on plant juices and are commonly found in flowers, and on the leaves and fruit of trees. A few species eat fungi and decayed vegetable matter, while still a fewer number are predaceous on mites and small insects. Many of the plant-infesting species are serious pests. They

[1] Formerly *Physapoda*.

The common name thrips is used in the singular and plural sense alike.

J. Uzel, *Monog. Thysanoptera*. Königgrätz, 1895.

Theo. Pergande, "Observations on Certain *Thripidæ*." *Insect Life*, 7, 1895, p. 390.

S. M. Daniel, "Key to Genera of *Thysanoptera*." *Ent News*, 15, 1903, p. 293.

W. E. Hinds, "Mon. N. A. *Thysanoptera*." *Proc. U. S. Nat. Mus.*, 26, 1904, p. 79.

D. Moulton, "Contrib. to Knowledge of *Thysanoptera* of Calif." *Tech. Ser.*, 12, pt. 3, Bur. Ent. U. S. Dept. Agr., Apr. 5, 1907. "*Syn. Cat. Biblio. N. A. Thysanoptera.*" *Tech. Ser.*, 21, Bur. Ent. U. S. Dept. Agr., June 13, 1911.

D. L. Crawford, "Notes on Calif. *Thysanoptera*." *P. C. Jour. Ent.*, 1, 1909, p. 120; 2, 1910, p. 149.

P. R. Jones, "Some New California and Georgia *Thysanoptera*." *Tech. Ser.*, 23, pt. 1, Bur. Ent. U. S. Dept. Agr. 1912.

A. C. Morgan, "New Genera and Species of *Thysanoptera* with Notes on Distribution and Food Plants." *Proc. U. S. Nat. Mus.*, 46, 1913, p. 1.

J. Douglas Hood, *Proc. Biol. Soc. Wash.*, 26, 1913, p. 163. "Proper Generic Names for Certain *Thysanoptera* of Economic Importance." *Proc. Ent. Soc. Wash.*, 16, 1914, p. 34. *Insec. Inscit. Menstruus*, 5, 1917, p. 55.

R. C. Treherne, "Notes on *Thysanoptera* from B. C." *Can. Ent.*, 51, 1919, p. 181.

J. R. Watson, *Synopsis and Catalog of the Thysanoptera of N. A.* Tech. Bul. 168, Fla. Agr. Exp. Sta. 1923.

often completely destroy the buds or blossoms, whiten, curl, or deform the leaves, and scab or deform the fruit. Many of the species which normally feed on grasses and weeds in the uncultivated areas migrate to the cultivated fields and orchards when the native vegetation begins to dry up, and then often do a great deal of damage particularly to developing young fruit in orchards. The eggs are laid on the bark or on the surfaces of leaves, or they may be inserted by means of the sharp ovipositor in the tissues of plants. They are usually laid in the spring of the year by adults which hibernate over winter. Many generations follow during the summer and fall, although in some species like the pear thrips there is but one generation. In the latter the nymphs leave the plants in early summer, May or June, and go into the soil, there following a resting period until winter when the adult stage is reached; but emergence does not follow until early the next spring. There is a notable absence of males and parthenogenetic development without eggs is common.

Natural Enemies. The natural enemies which prey on thrips are not well known, but thrips are subject to much the same regulation as are other small insects. Ladybird beetles and their larvæ eat numbers of the young. The dark triphleps, *Triphleps tristicolor* White, is an effective predator on the young thrips throughout the west. The larvæ of the green lacewings, *Chrysopa* spp., and predaceous thrips are also important predators. The thrips parasite, *Thripoctenus russelli* Crawford, has been reared from a number of species in California, but its effectiveness is uncertain.

Control. The control of thrips has been effectually worked out so that for most species there is no difficulty at all in protecting the plants subject to their attacks. Two types of insecticides are used: sprays and dusts. The most effective sprays are composed of an oil emulsion or miscible oil with nicotine sulfate as follows:

Distillate Emulsion	6 gallons
or	
(Miscible Oil	3 gallons)
Nicotine sulfate 40%	1½ pints
Water to make	200 gallons.

On very tender plants it is necessary to reduce the distillate emulsion or the miscible oil to one-half the above recommended strength or they may be omitted altogether.

The dust found most effective for general control is one composed of two per cent pure nicotine, or what is also known as a five per cent nicodust, and which contains five per cent of the forty per cent nicotine sulfate. For orchard work where fungous diseases, like apple mildew, occur, or where red spiders are also present, a five per cent nico-sulfur dust is recommended as a combined insecticide and fungicide. A twenty-five per cent calcium cyanide dust is also effective in controlling most species.

In either spraying or dusting it is necessary to be thorough in order to cover the under surfaces of the leaves where the thrips are most likely to occur. If thoroughly done, spraying is more effective than dusting and is the only way some of the thrips can be controlled.

Key to Suborders and Families

1. *Female with a saw-like ovipositor; last abdominal segment of female conical,* that of the male broadly rounded; wings usually present, the front pair largest, usually with well developed veins and always with at least one longitudinal vein extending from the base to the apex; wing membrane with microscopic hairs. (Suborder **Terebrantia**) 2

   Female without a modified ovipositor; the last segment of the abdomen tubular in both sexes; wings absent or present, both pairs similar in structure, the front wings with only a median longitudinal vein which does not extend to the tip of the wings; wing membrane without microscopic hairs. (Suborder **Tubulifera**) . . . . **Phlœothripidæ** p. 191

2. Ovipositor curved upwards; front wings broad, rounded and with prominent veins; antennæ 9-jointed . . . . **Æolothripidæ**

   Ovipositor curved downwards; wings when present usually narrow and pointed at tips; antennæ 7- to 10-jointed . . . . **Thripidæ** p. 182

ÆOLOTHRIPIDÆ. The Broad-Winged Thrips.

The annectent thrips, *Æolothrips annectans* Hood, has clouded wings with a pale spot at the base, one at the middle on the costal margin, and another at the tip. It is predaceous on other thrips and occurs on maple, wild currant, elderberry, European holly, apple, alder, gromwell, pear, locust, and Florida shadberry, and is common in British Columbia.

The golden thrips, *Æolothrips auricestus* Treherne, is golden brown, the fore wings with two dark cross bands and three pale areas of equal width, the hind wings similar but paler. It occurs on wild rye in British Columbia.

The striped or banded thrips, *Æolothrips fasciatus* (Linn.) (*Thrips fasciata* Linn., *Coleothrips trifasciata* Fitch), is 1.63 mm. long, yellowish to dark brown with paler hind wings. The preceding species appears to be very close if not identical with this species. It is predaceous and has been taken on alfalfa, buckwheat, buckeye, celery, cherry, sand cherry, clover, dahlia, oats, chrysanthemum, hawthorn, gromwell, onion, sticky monkey flower, tansy, grasses, shadberry, sugar beets, wild tobacco, wild rye, and so forth. It is a widely distributed species in Europe and North America and is known in British Columbia, Oregon, California, Arizona, and New Mexico in the West.

Kuwana's thrips, *Æolothrips kuwanai* Moulton, is 1.66 mm. long, pale to dark brown with conspicuous reddish blotches showing between the body segments. The costal half of the front wings is whitish while the posterior half is dark, and when folded the white areas overlap so as to make a conspicuous white line down the middle of the dorsum. It is common in Central California in the blossoms of *Ceanothus* spp., elderberry, greasewood, lupine, cherry, peach, plum, and prune. H. E. Woodworth has observed it feeding on *Scirtothrips citri* (Moulton) in Tulare County, California.

The artemisia thrips, *Æolothrips longiceps* Crawford, is 1.33 mm. long, dark brown, wings clouded much as in *A. kuwanai* Moult., but without veins. It occurs on California sage in Southern California.

The Arizona blossom thrips, *Erythrothrips arizonæ* Moulton, is 2.66 mm. long, dark brown with red pigmentation, front wings white with dark posterior longitudinal border from base to tip and with two longitudinal and four cross veins. It occurs in the blossoms of orange and olive in Arizona and on cascara in California.

Kellogg's thrips, *Orothrips kelloggi* Moulton, is 1.80 mm. long, light to dark brown, the prothorax and abdomen shaded with orange, front wings clear with three dark areas, one at base, one near middle, and one at tip; the five cross veins are included in the central dark area. It feeds in the flowers of madrona, manzanita, and Japanese

plums. The variety *yosemiti* Moult., is darker in color and has been taken in flowers of *Ceanothus* at high altitudes in California and on shad bush in British Columbia.[1]

The robust thrips, *Ankothrips robustus* Crawford, is 1.46 mm. long, dark brown to black, fore wings pale brown, hind wings clear. It occurs on California laurel and wild lilac in California.

THRIPIDÆ. The Narrow-Winged Thrips.

The dracæna thrips, *Parthenothrips dracænæ* (Heeger) (*Heliothrips*), is 1.15 mm. long, dusky yellow, abdomen shaded with brown, head, thorax, and wings reticulated, fore wings very long with three faint spots on the costal margin, and one larger spot on the hind margin. It feeds on dracæna, rubber tree, kentia palm, sago palm, and century plant, and occurs in Europe and North America. In the west it is reported from California.

Pierce's thrips, *Microthrips piercei* Morgan, is a very small species only 0.62 mm. long, brownish yellow with pale legs; antennæ 7-jointed. It has been taken on veronica in Texas, papaw in Tennessee, and has proven injurious to young cotton plants in Arizona.[2]

Bremner's thrips, *Thrips bremneri* Moulton, is 1.08 mm. long, very pale lemon yellow to brown, slender with the head longer than wide. It has been taken in the fruit of ripe figs, Santa Clara Valley, California.

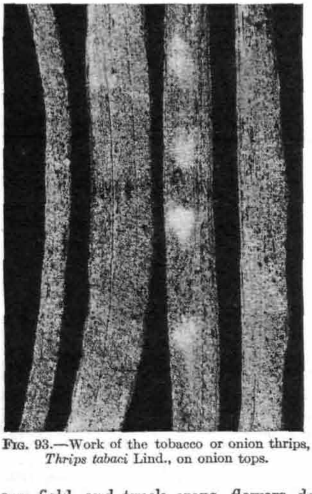

FIG. 93.—Work of the tobacco or onion thrips, *Thrips tabaci* Lind., on onion tops.

The madrona thrips, *Thrips madroni* Moulton, is 1.25 mm. long, from pale yellow to uniform dark brown, wings paler at the base. It occurs in Oregon and California on California lilac, dandelion, madrona, nightshade, azalea, elderberry, rhododendron, and in the flowers of lemon in California.

The European thrips, *Thrips physapus* Linn.,[3] is a dark golden species, common in British Columbia on dandelion and in flowers of thimbleberry, and often associated with the pear thrips in blossoms of pears, plums, and prunes.

The tobacco or onion thrips, *Thrips tabaci* Lindeman, varies from 1 to 1.20 mm. in length, and is pale yellowish to light brown in color, 7-jointed antennæ, with hairs on the compound eyes. The eggs are reniform, white, and 0.26 mm. long. The young are pale yellowish or greenish, often dusky. The winter is passed in the nymphal or adult stage in refuse or on grasses and weeds. This species is common throughout Europe and North America and occurs in every Western State. It is a general feeder on grasses, weeds, forage, field, and truck crops, flowers, deciduous fruit trees, berries, and so on, and is often a very serious pest to onions (Fig. 93), which may be entirely

[1] R. C. Treherne, *Can. Ent.*, 51, 1919, p. 181.

[2] A. W. Morrill, *Jour. Econ. Ent.* 10, 1917, p. 314.

[3] H. Uzel gives *physopus* as the correct spelling, but his version has not been generally accepted.

destroyed by the attacks on the leaves, which gradually become whitened and subsequently dry up. The thrips become more or less accumulative in districts where successive crops of onions are produced, being carried over the winter in trash and volunteer onions in and about the fields.

The large thrips, *Thrips magnus* Moulton, varies from 1.70 to 2 mm. in length and is very dark brown. It has been taken from the blossoms of the monkey flower in the San Joaquin Valley, California.

The banded-winged thrips, *Heliothrips fasciapennis* Hinds, is 0.92 mm. long, yellowish or dark brown, body reticulated, fore wings with four dark and three light areas. It is an eastern species, occurring on grasses. In the Sacramento Valley, California, it attacks cotton plants.

The bean thrips, *Heliothrips fasciatus* Pergande[1] (*Caliothrips woodworthi* Daniel)[2] (Fig. 94), averages 1 mm. in length, body reticulated, dark brown, front wings with two pale and three dark areas, and the antennæ 8-jointed.

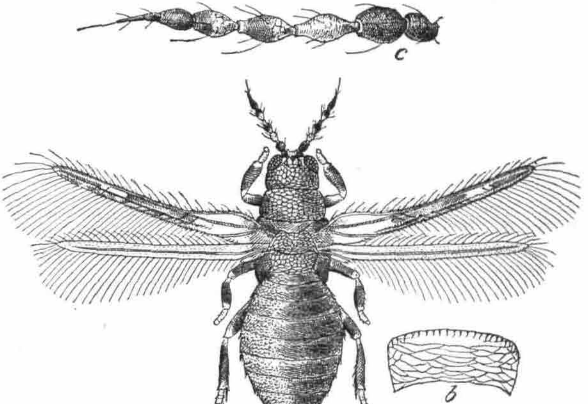

FIG. 94.—The bean thrips, *Heliothrips fasciatus* Perg. *a*, adult; *b*, venter of abdominal segment; *c*, antenna. (After Russell, U. S. Dept. Agr.)

The small white, reniform eggs are inserted in the tissues of the host plants. The nymphs are pale yellowish green with reddish markings over the dorsum. The adults hibernate and begin egglaying in the early spring. There are from 5 to 7 generations a year. This species is a general feeder on leguminous plants, truck, field and forage crops, grasses, deciduous and

[1] *Insect Life*, 7, 1895, p. 391. Orig. desc.
H. M. Russell. *The Bean Thrips*. Bul. 118, Bur. Ent. U. S. Dept. Agric. 1912.
[2] S. M. Daniel, *Ent. News*, 15, 1904, p. 297.

citrus fruit trees, and so forth, and is a serious pest to beans and cotton in California and Arizona, and to the fruit of oranges, avocados, and olives in California. It is generally distributed throughout the country. In the west it is known to occur in California, Idaho, Nevada, and Arizona, but undoubtedly has a much wider distribution. The thrips parasite, *Thripoctenus russelli* Crawford, has been reared from nymphs and adults, and kills as high as seventy per cent of them at times in Southern California. This parasite, however, is not a factor in control under ordinary conditions.

The sugar beet thrips, *Heliothrips femoralis* Reuter (*H. cestri* Pergande),[1] is from 1 to 1.30 mm. long, color dark brown or black with the head, prothorax, and end of the abdomen reddish yellow. The fore wings are dusky with a white area near the base, one near the middle, and one at the tip. It is a widely distributed species first recorded on sugar beets in Europe and

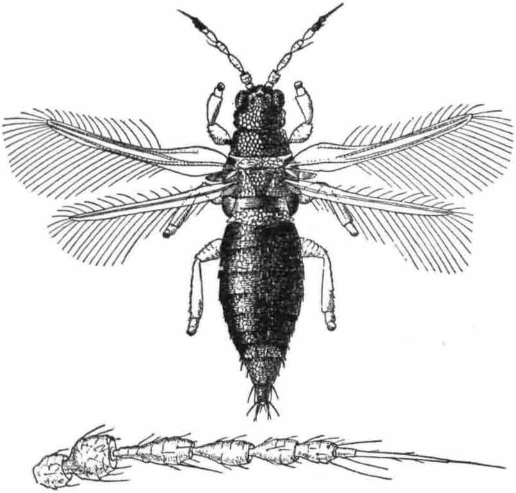

FIG. 95.—The greenhouse thrips, *Heliothrips hæmorrhoidalis* (Bouché). Adult and antenna. (After Russell, U. S. Dept. Agr.)

on sugar cane in Porto Rico. In the United States it has been taken on night-blooming jassamine, amaryllis, aralia, calla, chrysanthemum, spinach, cucumber, dracæna, rubber tree, gardenia, cotton, hydrangea, moon flower, screw pine, tomato, begonia, grape, sugar beet, sweet potato, string bean, Mexican tea, and so on. It is recorded from the date palm in Arizona and from sugar beets in California.

[1] W. H. White, Bul. 421. *Prof. Paper*, U. S. Dept. Agr. 1916.

The greenhouse thrips, *Heliothrips hæmorrhoidalis* (Bouché) (Fig. 95), averages 1.23 mm. in length, is very dark brown to almost black, with reticulated surface and 8-jointed antennæ. The life history is much the same as that of the bean thrips. This species is a greenhouse pest in many parts of the United States, while in the west, although it is often taken in such places, yet is more often met outside on ornamental trees and shrubs, including apple, avocado, azalea, begonia, calla lillies, cherry, citrus, croton, cyclamen, eucalyptus, euonymus, dahlia, ferns, fiddleweed, fig, fuchsia, grape, kola, laurel, laurestinus, mango, maple, Norfolk Island pine, palms, phlox, pinks, smilax, verbena, viburnum, and many others. It is almost cosmopolitan and occurs in Europe, Asia, South Sea Islands, and North America. In Germany it is known as the black fly.

The apterous thrips,[1] *Sericothrips apteris* Daniel, is a small species 0.74 mm. long, wingless, very dark brown to black, and the antennæ 8-jointed. The pterthorax is paler than the rest of the body and is reticulated. It occurs on grasses and weeds in the San Francisco Bay Region, California.

The reticulated thrips,[1] *Sericothrips reticulatus* Moulton, is 1.41 mm. long, wingless, brown with head and thorax paler and legs yellow, and with the dorsal surface heavily reticulated. It infests grasses in the San Francisco Bay Region, California.

The Stanford thrips,[1] *Sericothrips stanfordi* Moulton, is 1.25 mm. long, wingless, brown in color, with cross striæ on dorsum of head and thorax. It infests grasses in the San Francisco Bay Region, California.

The manicate thrips, *Chirothrips manicatus* (Haliday) (*Thrips*), is 1 mm. long, uniform dark yellowish brown, 8-jointed antennæ, wings of female not quite so long as the body, absent in the male. It is a European species occurring in British Columbia and Oregon and in various parts of the United States. It infests the flowers of grasses, cereals, clover, wild carrot, and so forth.

The rufous thrips, *Aptinothrips rufus* (Gmelin) (*Thrips rufa* Gmelin), is 1.22 mm. long, slender, uniform clear yellow, shaded brown. It is a European species, found in various parts of the United States and in the San Francisco Bay Region, California. It infests grasses.

The six-spotted thrips, *Scolothrips sexmaculatus* (Pergande) (*Thrips*)[2] (Fig. 96), is a small species 0.83 mm. long, pale yellow with three brown spots on each of the fore wings. This is a beneficial species often abundant and preying on the eggs and young of small orchard mites, particularly the brown mite, the European red mite, the two-spotted mite, and the common red spider, in Oregon and California. It is recorded elsewhere in the United States and in the Hawaiian Islands.

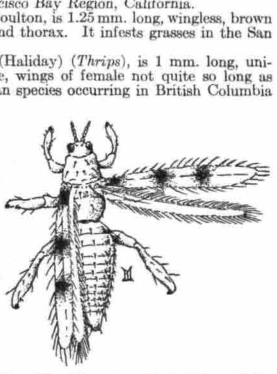

FIG. 96.—The six-spotted thrips, *Scolothrips sexmaculatus* (Perg.). (After Quayle.)

The citrus thrips, *Scirtothrips citri* (Moulton) (*Euthrips*)[3], is a small pale yellow or orange-colored species 0.86 mm. long. It is the most serious thrips, attacking orange trees in Arizona and California and does great damage by injuring the young fruit at blooming time and later, so as to pro-

[1] Recently placed in the genus *Anaphothrips*.
[2] H. J. Quayle, Bul. 234, Cal. Agr. Exp. Sta. 1912, p. 513.
[3] D. Moulton, *Tech. Ser.*, 12, pt. 7, Bur. Ent. U. S. Dept. Agr. 1909.
P. R. Jones and J. R. Horton, Bul. 99, pt. 1, Bur. Ent. U. S. Dept. Agr. 1916.
J. R. Horton, *Farmers' Bul.*, 674, U. S. Dept. Agr. 1915. Bul. 616, Prof. Paper, Bur. Ent. U. S. Dept. Agr., 1918.

duce scabby areas over the outer rind, often in the form of rings about either or both ends or about the points of contact where two fruits touch (Fig. 97). Because of its prevalence on oranges it was first known as the orange thrips, but the more general term citrus thrips is a better designation because it attacks all varieties of citrus trees. The adults hibernate on the trees or weeds in the orchards and lay the small whitish reniform eggs on the surfaces of the tender leaves and shoots in April and throughout the

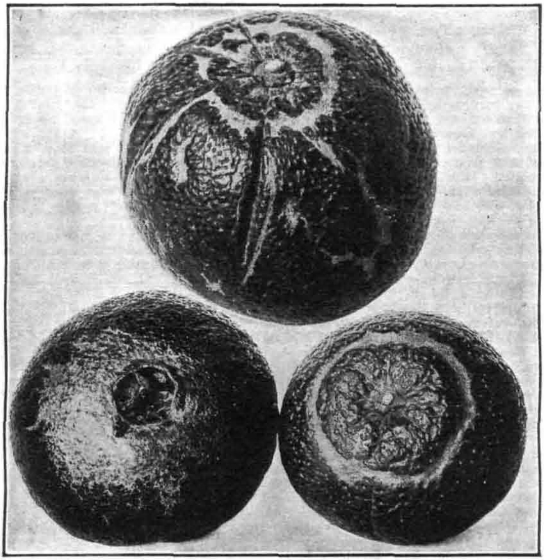

Fig. 97.—Work of the citrus thrips, *Scirtothrips citri* (Moulton), on oranges. (After Quayle.)

summer, there being several broods a year. The young and adults feed on the young and tender leaves, shoots, flowers, and fruit and besides scabbing and deforming the fruit, cause a withering and curling of the leaves and often a dropping of the blossoms before the fruit is set. The citrus thrips is a lover of a hot, dry climate, and is injurious chiefly in such citrus growing districts as Arizona and the warmer inland valleys of California. Besides citrus it is known to feed on European grape, apricot, peach, pear, plum, olive, raspberry, rose, purslane, nightshade, dock, pepper tree, umbrella tree, willow, and alfalfa. Some of the citrus growers in the Salt River

Valley, Arizona, claim to have far less trouble with the citrus thrips in orchards interplanted with alfalfa than where only clean culture is practiced. Control measures have been proven successful wherever the work is thoroughly done. The oil emulsion or miscible oil and nicotine spray as recommended at the beginning of this chapter is the most effective. A two per cent commercial lime-sulfur spray, and a five per cent nicodust have also proven satisfactory under certain conditions, but have failed under other conditions. It is important to start spraying when the thrips first appear in sufficient numbers and to repeat as necessity arises.

The cotton thrips, *Frankliniella gossypii* (Morgan) (*Euthrips*), is 1 to 1.30 mm. long, yellowish-gray in color, and occurs in the tender tips of cotton plants at Yuma, Arizona.

The sunflower thrips, *Frankliniella helianthi* (Moulton) (*Euthrips*), is 1.25 mm. long, and yellow gray and brown in color. It normally feeds in the blossoms of wild sunflowers and is thought by G. P. Weldon [1] and others to be the thrips often responsible for the serious scarring of the young fruit of peaches and apricots in many parts of California, usually attributed to the wheat trips. (See Fig. 98). It does not readily succumb to dusting, but yields to the oil emulsion and nicotine sprays. Control measures must begin as soon as or shortly after the blossom petals fall to insure complete protection. This thrips occurs throughout California and is most injurious in the warmer interior districts.

The insular thrips, *Frankliniella insularis* (Franklin) (*Euthrips*),[2] is from 1.43 to 2.12 mm. long, and brown in color. It was originally taken from the West Indies and Barbados Islands, Central America, Mexico, and Texas on lupine, morning glory, willow, arrow root, and other plants, and in the flowers of wild cotton, *Thurberia*, in Arizona.[3]

The small thrips, *Frankliniella minuta* (Moulton) (*Euthrips minutus* Moulton), is but 0.83 mm. long and of a uniform dark brown color. It occurs throughout California on the foliage and in the blossoms of cherry, pear, prune, grasses, yarrow, greasewood, sunflower, and buttercup.

The apricot thrips, *Frankliniella morrilli* Morgan,[4] scars and deforms the fruit of apricots in Arizona much as the sunflower and wheat thrips scar the fruit of apricots and peaches in California. The nymphs are most active and injurious in April and almost disappear by May.

The western thrips, *Frankliniella occidentalis* (Pergande) (*Euthrips*),[5] is a small species averaging about 1 mm. in length. The color is orange yellow with dusky markings on the sides of the abdomen. It is similar to the wheat thrips, but has larger eyes, shorter head, much longer terminal antennal joint, and stouter and more prominent bristles on the head, thorax, and wings. It is common in California and feeds in flowers of orange, lemon, milkweed, apricot, peach, alfalfa, potato, marsh rush, and various weeds. According to Crawford [6] this species is at times a serious pest to potatoes, and thought to spread early blight. The nymphs pass a quiescent stage in the ground under the dead leaves close to the food plants. The fruits of oranges and lemons are scarred by it. Morgan reports it on mango in Florida.

The wheat or flower thrips, *Frankliniella tritici* (Fitch (*Thrips, Euthrips*), averages 1.23 mm., long and slender, and is amber yellow with bright orange thorax. It is the most abundant and widely distributed species, occurring in every locality throughout the country and is responsible for a great deal of damage not generally known. It is an omnivorous feeder on wild grasses, weeds, flowers, field, forage and truck crops, deciduous and citrus fruit trees, berries, vines, and in fact on nearly all types of plant life.

[1] *Jour. Econ. Ent.*, 14, 1921, p. 428.
[2] H. J. Franklin, *Proc. U. S. Nat. Mus.*, 33, 1908, p. 715. Orig. desc.
[3] W. D. Pierce and A. W. Morrill, *Proc. Ent. Soc. Wash.*, 16, 1914, p. 21.
[4] A. W. Morrill, *Ninth Ann. Rept.*, Ariz. Comm. Agr. and Hort. 1917, p. 38.
[5] Theo. Pergande, *Insect Life*, 7, 1895, p. 392.
[6] D. L. Crawford, *Mthly. Bul.* Cal. State Comm. Hort., 4, 1915, p. 389.

Serious losses are occasioned by its attacks in the flowers of alfalfa, clover, wheat, grapes, peaches, apricots, strawberries, blackberries, and tomatoes, and the fruits of apricots, peaches, plums, prunes, grapes, and oranges are deformed and scarred by the nymphs and adults. This species breeds in the grasslands, forage and field crops, and waste areas in the spring, and when the plants begin to dry up in early summer the thrips migrate to the orchards, gardens, and cultivated fields in sufficient numbers to occasion great losses in a very short time. In some parts of California and Arizona, the young fruit of peaches and apricots are scarred almost beyond recognition (Fig. 98). In all the Western States the production of alfalfa seed is

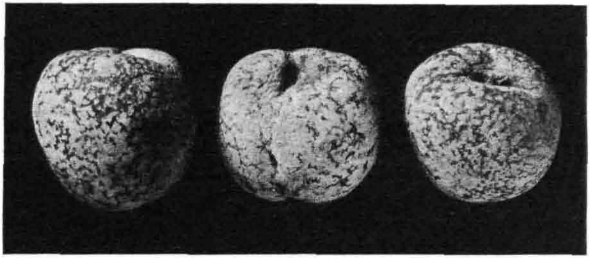

FIG. 98.—Work of the wheat thrips. *Frankliniella tritici* (Fitch), on peaches.

greatly reduced by the work of the wheat thrips in the flowers. Although some thrips may occasion greater losses to one or more crops, this species outdoes all others in the amount of damage in the aggregate to all kinds of crops.

Control measures consist in thorough spraying as recommended in the beginning of the chapter. Dusting appears to afford little relief.

The variety *F. tritici californicus* Moulton, is a color phase in company with the true species, in Washington, Oregon, and California. (Now named *F. moultoni* Hood).

The Arizona cotton thrips, *Anaphothrips arizonensis* (Morgan), is 0.96 mm. long, whitish to pale yellow, and is sometimes quite destructive to cotton in Arizona. It also feeds on snakeweed.

The grass thrips, *Anaphothrips obscurus* (Mull.) (*Thrips striata* Osborn), varies from 1 to 1.6 mm. in length and is yellow with brownish markings. It is the common grass and grain-infesting species of the Eastern States and is responsible for a whitening of the panicle which is known as silver top and causes sterility of the seeds of grasses, barley, oats, wheat, timothy, and so forth. In Montana it is sometimes a serious pest to cereal crops [1] and has been taken on alfalfa, grasses, and corn in California. It is also known in Idaho, Utah, and Arizona, and probably occurs in other Western States.

The long-winged thrips, *Scirtothrips longipennis* (Crawford) (*Anaphothrips*), is 0.96 mm. long, whitish to brownish yellow with long wings extending beyond the tip of the abdomen by one-fourth their length. It has been taken from olive and pine in Southern California.

The three-colored thrips, *Scirtothrips tricolor* (Moulton) (*Anaphothrips*), is 1.6 mm. long, the head and thorax are yellow, the pterthorax orange, and the abdomen brown. It has been found on goldenrod and young orange trees in Tulare County, California.

[1] R. A. Cooley, *14th Ann. Rept.*, State Ent. Bul. 112, Mont. Agr. Exp. Sta., p. 56, 1916.

The corn thrips, *Scirtothrips zeæ* (Moulton) (*Anaphothrips*), is 1.10 mm. long and yellowish to brown with gray wings. It is recorded by Moulton on grasses, on the ears and leaves of corn, and on orange foliage in various parts of California.

The white thrips, *Scirtothrips albus* (Moulton) (*Physothrips, Euthrips*), is 1 mm. long and translucent white with all of the antennal joints brown excepting the three near the head. It has been taken on peach at Red Bluff, California.

Ehrhorn's thrips, *Physothrips ehrhorni* (Moulton) (*Euthrips*), is 1.20 mm. long, brown with pale head. It feeds on grasses and leaves of prune trees in the Santa Clara Valley, California, and is likely to be confused with the pear thrips.

The pear thrips, *Tæniothrips inconsequens* (Uzel) (*Physopus, Euthrips pyri* Daniel) [1] (Fig. 99), is a serious pest on pear, prune, plum, and cherry particularly in California, but is now known in British Columbia, Oregon,

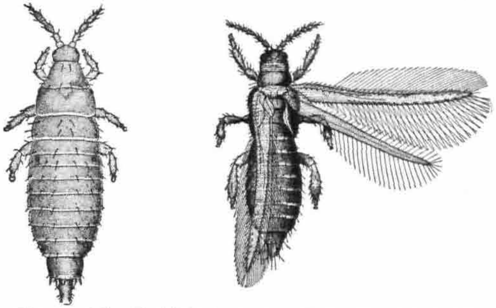

FIG. 99.—The pear thrips, *Tæniothrips inconsequens* (Uzel). Nymph and adult. (After Moulton, U. S. Dept. Agr.)

New York, and Ontario, Canada. It was originally supposed to be a native insect but we now believe that it was imported from Europe on nursery stock. There are so many bulletins and articles on this species that the reader will not find a complete discussion necessary here. The adults are 1.26 mm. long, dark brown to almost black, antennæ 8-jointed, the seventh joint about twice as long as the eighth. The eggs are microscopic, white, reniform, and are deposited under the epidermis of the leaf and blossom petioles. The young are whitish in color and are commonly called white thrips in contrast to the adults which are known as black thrips.

The pear thrips spends the larger part of its life cycle in the soil beneath the depth of cultivation as an immature, white thrips in æstivation and

[1] S. M. Daniel, *Ent. News*, 15, p. 294, 1904. Orig. desc. as *E. pyri*.
D. Moulton, Bul. 68, pt. 1, Bur. Ent. U. S. Dept. Agr. 1907. Bul. 80, pt. 4, Bur. Ent. U. S. Dept. Agr., p. 51, 1909.
P. J. Parrott, Bul. 343, N. Y. Agr. Exp. Sta. 1912.
Earl Morris, Bul. 228, Cal. Agr. Exp. Sta., 1912.
S. W. Foster and P. R. Jones, Bul. 173, *Prof. Paper*, U. S. Dept. Agr. 1915.
R. C. Treherne, *Proc. B. C. Ent. Soc.*, p. 80, 1916. *Can. Ent.*, 51, p. 185, 1919.
J. W. Eastman, Bul. 68, Dept. Agr. and Hort. Br. Victoria, B. C., 1916.
E. O. Essig, Circ. 223, Cal. Agr. Exp. Sta., 1920.
A. L. Lovett, *Third Crop Pest and Hort. Rept.*, Ore. Agr. Exp. Sta., p. 95, 1920.

hibernation. These young drop from the trees in May and June, enter to a considerable depth below the surface and remain in a quiescent pupal stage in small cells where transformation to the adult takes place in late October or early November, so that in reality the hibernation takes place in the adult stage in the soil. The black thrips begin to emerge in February about the time the first buds of the early prune trees begin to swell and often a week or more in advance of the blooming period. They feed on the opening flower buds and are often sufficiently abundant to devastate every bud in an orchard so that the trees never come into bloom. Where not sufficiently abundant to seriously injure the buds, the adults continue to feed in the flowers and lay their tiny eggs chiefly in the stems or petioles of the blossoms. The black thrips may continue in the orchards for several weeks after blooming, but the great majority die soon after egg-laying. The eggs hatch while the trees are still in bloom or soon after the petals fall and the young white thrips begin to feed on the developing fruit and on the unfolding leaves, remaining for two or three weeks or until about the middle of May, when they begin to go into the soil, continuing until the latter part of June when the last stragglers disappear. The white thrips cause a scarring of the fruit and perforations in the leaves between the veins and are responsible for much loss in the deformed and scabby fruit. There is but one generation a year. The outbreaks are very irregular and spotted so that there is no assurance of a recurrence in any district at any given time.

The hosts of this thrips are the blossoms, fruit, and leaves of cherry, apricot, almond, apple, fig, grape, peach, pear, plum, prune, and similar fruit trees, and also the blossoms of acacia, and foliage of poplar, fir, maple, June or shadberry, willow, red flowering currant, choke cherry, walnut, anemone, weeds, shrubs, and so forth.

The pear thrips was first described in Europe in 1895 and first came to notice in California in 1904. Since that time there have been a number of serious outbreaks, which resulted in a large amount of life history studies and control work by federal, state, and county officials, with the result that this insect is controlled and is no longer feared as an orchard pest.

In the west it appears to prefer the cooler coastal regions to the warmer interior and is confined to the San Francisco Bay Region in California. In Oregon it is in a small area between Salem and Albany and in the Walla Walla Valley. In British Columbia it is along the southwest coast.

The sprays and dusts given in the control measures at the beginning of the chapter are applicable for this species. Spraying, though more difficult because of the wet condition of the soil in early spring, is undoubtedly more effective than dusting, but the latter is very satisfactory and fast gaining precedence. For the black thrips the spray formula should be strengthened to include ten gallons of distillate emulsion or five gallons of miscible oil, one pint of forty per cent nicotine sulfate to 200 gallons of water, and the weaker solution of six gallons of distillate emulsion or three gallons of miscible oil to the same amount of nicotine sulfate and water for the white thrips. The free use of heavy cover crops, late fall plowing, and late fall irrigation are orchard practices of great practical significance in the control of this pest and often hold it in complete subjugation without spraying or dusting.

PHLŒOTHRIPIDÆ. The Tubular Thrips.

The toothed-thrips, *Trichothrips dens* Moulton, is 1.50 mm. long, brown with bright red blotches on the body and legs, and with a conspicuous tooth on each of the fore tarsi. It has been taken on apricot trees in the Santa Clara Valley, California.

Doane's thrips, *Acanthothrips cortices* (De Geer) (*A. doanei* Moulton), is 2.40 mm. long, dark brown, with tips of tibiæ, tarsi and basal and distal tips of antennal segments three to six inclusive, paler. It occurs on grasses in the foothills of the Santa Clara Valley, California.

The wandering thrips, *Cephalothrips errans* Moulton, varies from 1.16 mm. long for the wingless female to 1.86 mm., for the winged male. The color is uniform dark brown, the tips of the tibiæ and tarsi are pale. It has been taken on the foliage of apricot, prune, and mustard in the Santa Clara Valley, California.

The black hunter, *Leptothrips mali* (Fitch) (*Phlœothrips, Cryptothrips aspersus* Hinds, *C. californicus* Daniel, *Liothrips macconnelli* Crawf.),[1] is 1 to 1.7 mm. long, and very dark brown to blackish in color. The wings are clear white and when folded appear as a white line down the back. This is a common, widely distributed species which is predaceous on the eggs and young of various scale insects such as the black scale, brown apricot scale, and similar species, and on other small insects found on native shrubs and cultivated crops, fruit trees, vines, and ornamental flowers and plants. It is known in various parts of Mexico and the United States and is recorded from British Columbia, Oregon, and California in the west.

The wild buckwheat thrips, *Leptothrips fasciculatus* (Crawford) (*Liothrips, Phyllothrips*), is 1.55 mm. long and dark brown to black in color. It occurs on wild buckwheat in Southern California.

The Christmas berry thrips, *Liothrips ilex* (Moulton) (*Trichothrips*), is 1.70 mm. long, very dark brown to black, with all the tarsi, the tips of the fore tibiæ and segments three and four of the antennæ, yellow. The nymphs are bright cardinal red, with the head, antennæ, dorsum of the prothorax, legs and the last abdominal segment, black. The adults are common throughout California on Christmas berry and often cause curling and deformation of the leaves at the tips of the shoots. The writer has taken the adults and young on the leaves and stems of tree malva in Southern California. It also occurs on hollyhocks. A variety, *L. ilex dumosa* (Moulton), occurs on scrub oak in Central and Southern California.

The currant thrips, *Liothrips montanus* Hood, is black in the mature and light red in the young stage. It is a pest to the tender shoots of black currant, red currant, and gooseberry bushes in Montana.[2]

The statice thrips, *Haplothrips leucanthemi* (Schrank) (*Phlœothrips, P. niger* Osb., *Anthothrips, Haplothrips statices* Hal.), varies from 1.50 to 1.80 mm. long and is black with the tips of the legs and some of the middle antennal joints yellow. It is a European species introduced into America and is now found in British Columbia, Oregon, California, Utah, and Montana in the west. It infests many plants including yarrow, statice, corn, chrysanthemum, rudbeckia, red clover, apple, plum, tomato, rutabaga, grasses, and spirea. It is destructive to the red clover seed crop in Montana [3] and Idaho.[4]

[1] W. E. Hinds, *Proc. U. S. Nat. Mus.*, 26, p. 205, 1902. Orig. desc.
S. M. Daniel, *Ent. News*, 15, p. 293, 1904.
D. L. Crawford, *P. C. Journal Ent.*, 2, p. 163, 1910.
[2] R. A. Cooley, *Jour. Econ. Ent.*, 7, p. 194, 1914.
[3] R. C. Treherne, *Can. Ent.*, 51, p. 189, 1919.
[4] A. C. Burrill, *Jour. Econ. Ent.*, 11, p. 423, 1918.

CHAPTER XX

ANOPLURA (Order) [1]

(*Anoplos*, unarmed; *oura*, tail)

True Lice, Sucking Lice

The members of this order are small, more or less flattened, wingless, specialized, ecto-parasites, which are characterized by having simple metamorphosis, sucking mouth parts, short antennæ, and the tarsi ending in a single well developed claw. The head is small and narrow with an unjointed fleshy rostrum or beak for piercing and sucking, in contrast with the wide head and well developed biting mouth parts of the *Mallophaga*, with which they are often associated. The true lice pierce the flesh and suck the blood of the host thus producing fever, rash, and general lassitude by their bites. They are much more serious, however, in the rôle of disease carriers among humans and other mammals. The part played by lice in the transmission of typhus fever and other germ-born diseases during the last great war is an example of their economic importance to the human race.

The control of the true lice on domestic animals consists in the free use of sodium fluoride powders, and pine tar and other dips as recommended for the *Mallophaga*. In the case of the human-infesting species, cleanliness is the most important factor in their elimination. While certain of the human lice were common among school children and adults thirty or more years ago and it was no dishonor to dig for them, they are not entirely unknown to the present American born generations in this country, in spite of a better knowledge of the insects and higher standards of personal and home sanitation. The normal laundering of clothes usually kills all of the

[1] The order is also known by various other names as *Parasita*, *Siphunculata*, *Pseudorhynchota*, *Phthiroptera*, *Ellipoptera*, etc. It is placed in or near the *Mallophaga* by different writers.

H. Osborn, Bul. No. 7, Div. Ent. U. S. Dept. Agr. 1891, p. 7. Bul. No. 5, n. s. Div. Ent. U. S. Dept. Agr. 1896, p. 164.

V. L. Kellogg & G. F. Ferris, *Anoplura and Mallophaga of N. A. Mammals*. Leland Stanford Jr. Univ. Pub. Univ. Ser. 1915.

G. F. Ferris, "Notes on *Anoplura* and *Mallophaga*." *Psyche*, 23, 1916, p. 97. "A Catalogue and Host List of *Anoplura*." *Proc. Cal. Acad. Sci.*, 6, No. 6, May 12, 1916, p. 129. "*Mallophaga* and *Anoplura*." *Rept. Canadian Arctic Exped.*, 1913–1918, 3, Sept. 1919, p. 11D. "Contrib. Toward a Monograph of Sucking Lice." Pt. I. Leland Stanford Jr. Univ. Pub. Univ. Ser. 1919. Pt. II. Stanford Univ. Pub. Univ. Ser. *Biol. Sci.* 2, No. 2, 1921. Pt. III. *Ibid.*, No. 3, 1922; Pt. IV. No. 14, 1923. "De Anopluris." *Sci. Mthly.*, 15, pp. 551–556, 1922.

M. Imes, "Cattle Lice and How to Eradicate Them." *Farmers' Bul.*, 909, U. S. Dept. Agr., Feb. 1918.

G. F. Ferris kindly read and corrected this manuscript.

The scientific names of the hosts may be found in part in "A Distributional List of the Mammals of California." By Joseph Grinnell. *Proc. Cal. Acad. Sci.*, Ser. 4, 3, Aug. 28, 1913, p. 263.

eggs and adults present, although a special process may be necessary under abnormal conditions as during wars, famines, and so on.[1] Ointments of various kinds can also be had for local applications to the infested parts of the body.

KEY TO FAMILIES[2]

1. *Body with spines or hairs in definite rows, never with scales. Occurring only on land mammals* 2
   Body thickly beset with short, stout spines, or with spines and scales. Occurring only on marine mammals . . . . . **Echinophthiriidæ** p. 198
2. Head much elongated and cylindrical in shape; tibiæ without a thumb-like process opposing the claw. (A single genus found on elephants) . . . **Hæmatomyzidæ**
   Head not elongated; tibiæ with a thumb-like process opposing the claw 3
3. Eyes lacking . . . . . ***Hæmatopinidæ*** *p. 194*
   Eyes present, well pigmented. (Found on man, apes, and monkeys) . . . **Pediculidæ**

PEDICULIDÆ.

The head louse, *Pediculus capitis* DeGeer (*P. humanus* Linn.),[3] is a small whitish species with faint dark markings on the sides, from 1.8 to 2.7 mm. long. The last abdominal segment of the female is bilobed. The small white eggs or nits are glued to the hairs mostly behind the ears and at the nape of the neck. They hatch in about 6 days and the lice reach maturity in 18 days after hatching. This louse is confined chiefly to the head and only rarely occurs on other parts of the body. It produces severe itching and eczema-like eruptions of the skin. The insect is apparently as old as man and is cosmopolitan in distribution affecting man everywhere. It is abundant on Eskimos in the most isolated sections of Alaska and the North. Control measures consist chiefly in cleanliness. The lice and nits may be killed by repeatedly washing the head with a 2% carbolic acid solution, with pine tar and other oil emulsions, or with commercial sheep dips and mange cures.

The body louse, grayback or cootie, *Pediculus corporis* DeGeer (*P. vestimenti* Nitzsch),[3] is grayish in color and larger than the head louse, measuring from 3 to 3.3 mm. in length. The lice infest humans and hide in the seams and folds of the clothing and only come in contact with the skin when feeding. The eggs hatch in 8 days and the larvæ mature in 11 days. It is also an ancient and cosmopolitan species. Control[4] consists in thoroughly heating, boiling, or steaming the infested clothing. Zinc oxide ointment is recommended for the dermatitis of the skin.

The crab louse, *Phthirius*[5] *pubis* Linn. (*P. inguinalis* Leach), has the appearance of a miniature crab, being of the same general shape with well

[1] Wm. Moore & A. D. Hirschfelder, "An Investigation of the Louse Problem." *Research Pub.*, Univ. Minn. 8, No. 4, July 1919. Control Methods and Complete Bibliography of same.

[2] G. F. Ferris, *Proc. Cal., Acad. Sci.*, 4th. ser. 6, No. 6, May 12, 1916, p. 133. Also see same for key to genera, as known at that time.

[3] According to G. F. Ferris, "Geo. H. F. Nuttall and his co-workers have shown that there are not two species of *Pediculus*, that they are at most two races of one species passing readily from one form into the other."

[4] "Dry Cleaning Process of Q. M. C., U. S. Army." *Proc. Ent. Soc. Wash.*, 21, 1919, p. 8.

[5] Some modern authors spell this word *Phthirus* and use the same form for the endings of many of the generic names in this order.

developed claws. The color is whitish with a dusky patch on each shoulder, the claws bright and the legs pale reddish. The length varies from 1.5 to 2 mm. This species inhabits the regions of stiff hairs on the body as the pubic region, under the arms, in the beard and at times even in the eyebrows, but it is rarely found on the head of humans. It is a cosmopolitan species having been known from ancient times.

HÆMATOPINIDÆ.

The sucking horse louse, *Hæmatopinus asini* (Linn.) (*H. macrocephalus* Burm.), is yellow with brown head, thorax, and margins of the abdomen, and from 2.5 to 3.5 mm. long. It is a common species throughout the world on the horse, mule, and ass.

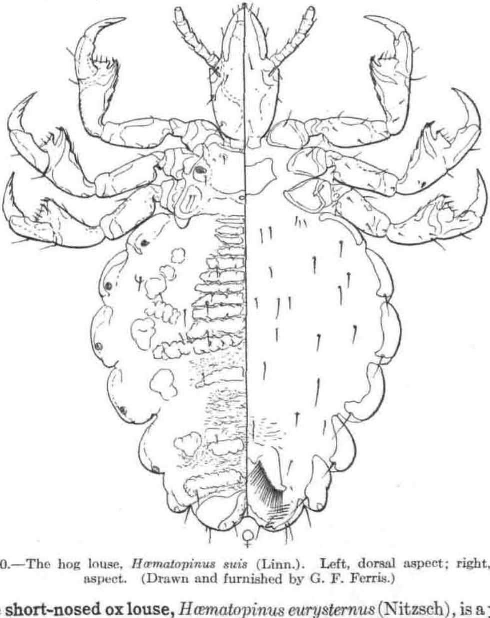

FIG. 100.—The hog louse, *Hæmatopinus suis* (Linn.). Left, dorsal aspect; right, ventral aspect. (Drawn and furnished by G. F. Ferris.)

The short-nosed ox louse, *Hæmatopinus eurysternus* (Nitzsch), is a yellowish-gray species from 2 to 3 mm. long, and characterized by the short bluntly-rounded head which is nearly as wide as long and the two black blotches on the last abdominal segment. It is a cosmopolitan species on cattle.

The hog louse, *Hæmatopinus suis* (Linn.) (*H. urius* Giebel)[1] (Fig. 100), is the largest of the common sucking lice, measuring from 5 to 6 mm. in length. It is gray with dark margins and reddish-brown thorax, the head is long and narrow, and the abdomen wide so that it has something of the appearance of the crab louse. It is a common and serious pest to hogs.

The buffalo louse, *Hæmatopinus tuberculatus* (Burmeister) (*Pediculus cameli* Linn.), is a widely distributed species occurring on buffalo in India and on the American bison throughout this country.

The California gray squirrel louse, *Enderleinellus kelloggi* Ferris, infests the California and black-footed gray squirrels in California. It occurs on gray squirrels in Mexico, Central America, and South America.

The long-headed squirrel louse, *Enderleinellus longiceps* Kellogg and Ferris, infests squirrels, *Sciurus* spp., in Colorado and Arizona (U. S., Mexico).

The Osborn ground squirrel louse, *Enderleinellus osborni* Kell. and Ferris, infests ground squirrels in California, Arizona, and Texas.

The chickaree louse, *Enderleinellus nitzschi* Fahrenholz (*Pediculus sphærocephalus* Nitzsch), infests the chickaree in Alaska, the Sierra chickaree in California, and Fremont squirrel in Colorado. (It also occurs in Europe.)

The western ground squirrel louse, *Enderlienellus suturalis* (Osborn) (*Hæmatopinus*), infests many kinds of ground squirrels in Alaska, Washington, Oregon, California, Nevada, Utah, and Colorado (U. S.). The variety *occidentalis* Kell. and Ferris, is recorded from the Sierra golden-mantled ground squirrel in California.

The Sierra Nevada Flying squirrel louse, *Microphthirus uncinatus* (Ferris) (*Enderleinellus*), infest the Sierra Nevada flying squirrel in California.

The kangaroo rat louse, *Fahrenholzia pinnata* Kell. and Ferris, is recorded from the California kangaroo rat and the big desert kangaroo rat in California, and from the Great Basin pocket mouse in Nevada. It also occurs in Oklahoma and Mexico.

The pocket mouse louse, *Fahrenholzia tribulosa tribulosa* Ferris, infests the California and long-tailed pocket mice in California. The subsp. *reducta* Ferris occurs on a related host at Victorville, California.

The sucking rabbit louse, *Hæmodipsus ventricosus* (Denny) (*Hæmatopinus*), is a common species on wild and domestic hares or rabbits in Europe and North America. It also infests the California jackrabbit in California and the Colorado Desert jackrabbit in Arizona.

The field mouse louse, *Hoplopleura acanthopus acanthopus* (Burmeister) (var. *americanus* Kell. and Ferris), is reported from Alaska lemming in Alaska; California meadow mouse and gray bushy-tailed wood rat in California; and red-backed mouse in Washington (other mice, Europe, N. A.).

The chipmunk louse, *Hoplopleura erratica arboricola* (Kell. and Ferris) (*H. arboricola* Kell. and Ferris), occurs on many species of squirrels and chipmunks in California. It is recorded from the Sonoma, alpine, Marin, Santa Cruz, redwood, and Tahoe chipmunks, the California gray and Douglas squirrels, the redwood and Sierra chickarees (U. S.).

The white-footed mouse louse, *Hoplopleura hesperomydis* (Osborn), is a widely distributed species in North America, South America, and Asia. In California it is recorded from the long-tailed harvest, house, and grasshopper mice, the redwood, Gambel, and Boyle white-footed mice, and in Colorado from the grasshopper mouse.

The hairy louse, *Hoplopleura hirsuta* Ferris, infests the western desert cotton rat in California, Arizona (Texas, U. S.).

The squirrel louse, *Hoplopleura sciuricola* Ferris (*H. arboricola* Kell. and Ferris, in part), occurs on the California gray squirrel and the Sierra and redwood chickarees in California, and on *Sciurus* spp. in Alaska and Arizona (U. S.).

The three-spined louse, *Hoplopleura trispinosa* Kellogg and Ferris, infests flying squirrels in California and Oregon (U. S.).

[1] E. C. Stevenson, Bul. No. 69, Bur. Anim. Ind. U. S. Dept. Agr. 1905.

M. Imes, "Hog Lice and Hog Mange." *Farmers' Bul.* 1085, U. S. Dept. Agr. May 1920.

Laura Florence, "The Hog Louse. Its Biology, Anatomy, and Histology." *Mem.* 51, Cornell Univ. Agr. Exp. Sta., Dec. 1921.

The sheep foot louse, *Linognathus pedalis* (Osborn) (*Hæmatopinus*), is a pale yellowish species 2.2 mm. long. It occurs chiefly on the legs and feet of sheep where the hair is short, but rarely invades the wool above the knees. It is common throughout our region and the country.

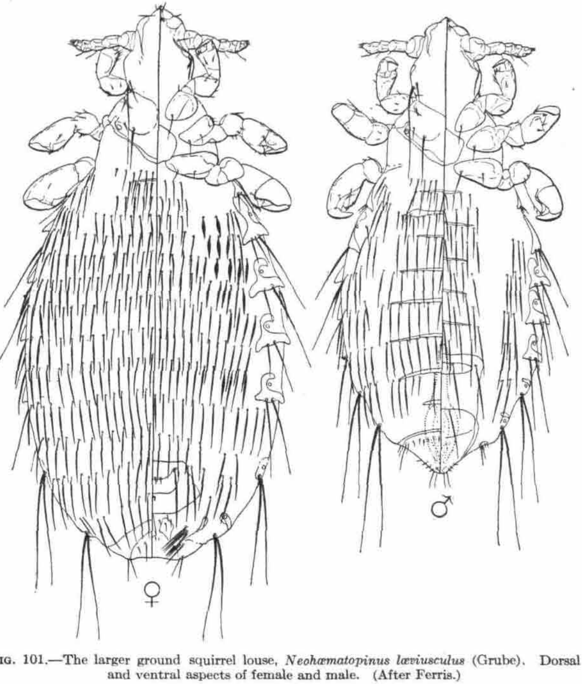

FIG. 101.—The larger ground squirrel louse, *Neohæmatopinus læviusculus* (Grube). Dorsal and ventral aspects of female and male. (After Ferris.)

The sucking dog louse, *Linognathus setosus* (Olfers) (*Pediculus piliferus* Burm.), is a yellowish or pinkish species common on dogs throughout the world. It has also been taken from the white fox in Alaska.

The sucking goat louse, *Linognathus stenopsis* (Burmeister), is a small species 2 mm. long, occurring on the domestic and Mexican goat in California (Europe, Africa).

The long-nosed ox louse or the blue cattle louse, *Linognathus vituli* Linn. (*Pediculus, Hæmatopinus tenuirostris* Burm.), is characterized by the long, slender head and slender body 2 mm. long. The color is chestnut or bluish. It is most serious on calves, but also infests cattle. The species is cosmopolitan and is common in the west.

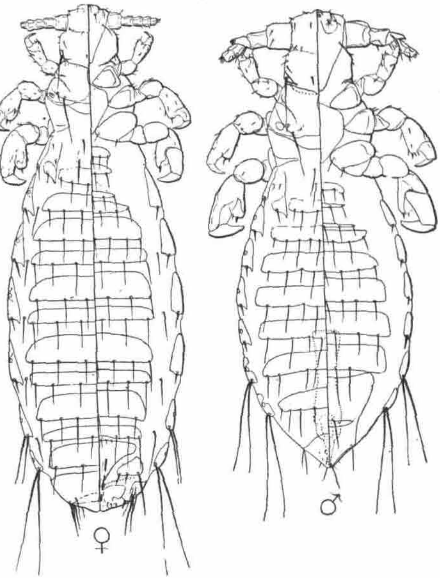

FIG. 102.—The spined rat louse, *Polyplax spinulosa* (Burm.). Dorsal and ventral aspects of female and male. (After Ferris.)

The capillate cattle louse, *Solenopotes capillatus* Enderlein,[1] is a small, amber yellow species with bluish-gray abdomen. The females are 1.5x0.7 mm. It infests range cattle in many parts of the United States, occurring in Oregon, Washington (Texas), in the west.

The sucking deer louse, *Cervophthirius*[2] *ferrisi* Mjöberg [*C. crassicornis* (Nitzsch)], has been taken from the Columbian black-tailed deer in California.

[1] F. C. Bishopp, *Jour. Agr. Research*, Wash., D. C., 21, 1921, p. 797.
[2] The form *phthirus* is now accepted by many authors as the proper way of spelling the ending of this genus and other genera in the *Anoplura* having this ending.

The wood rat louse, *Neohæmatopinus inornatus* (Kellogg and Ferris) (*Linognathoides*, has been taken from the western bushy-tailed wood rat, gray-tailed wood rat, and Streator wood rat in California.

The larger ground squirrel louse, *Neohæmatopinus læviusculus* (Grube) (*Pediculus, Hæmatopinus columbianus* Osborn, *H. montanus* Osborn) (Fig. 101), is stout bodied, 1.6–1.7 mm. long and infests ground squirrels, prairie dogs, marmots, ground hogs or woodchucks, and the western gray squirrels. It occurs in Siberia, Alaska, British Columbia, Washington, Oregon, California, Arizona, Mexico, and probably other Western States.

The marmot louse, *Neohæmatopinus marmotæ* Ferris [*Linognathoides montanus* (Osborn) Ferris, in part], infests the marmot and ground hog or woodchuck in the Yosemite Valley, California.

The tree squirrel louse, *Neohæmatopinus sciurinus* (Mjöberg) (*Hæmatopinus antennatus* Osborn), infests nearly all species of tree squirrels. It occurs in Europe, North America, Central America, and South America. In California it has been taken from the redwood and Sierra chickarees. The subsp. *griseicolus* Ferris infests the California gray squirrel in California.

The Pacific louse, *Neohæmatopinus pacificus* Kell. and Ferris, infests the alpine, Sonoma, Marin, and other chipmunks in California.

The flying squirrel louse, *Neohæmatopinus sciuropteri* (Osborn), occurs on flying squirrels in the United States and California.

The eared louse, *Polyplax auricularis* Kell. and Ferris, is distinguished by the ear-like projections on the head. It infests the white-footed mice throughout North America, the grasshopper mouse in Colorado; the redwood and Gambel white-footed mice, and the Arizona grasshopper mouse in California and Nevada.

The spined rat louse, *Polyplax spinulosa* (Burmeister) (Fig. 102), is a cosmopolitan species reported from various rats in Europe, Africa, North and South America, Australia, and the Pacific Islands; and from the California meadow and the long-tailed lemming mice in California.

ECHINOPHTHIRIIDÆ.

The seal louse, *Echinophthirius*[1] *horridus* (Olfers) (*E. phocæ* Lucas), infests harbor and other seals in the Pacific Ocean, Alaska (Greenland).

The sealion louse, *Antarctophthirus michrochir* (Trouessart and Neumann), occurs on the California sealion along the coast of California. It is also reported from Auckland Island, New Zealand.

The walrus louse, *Antarcotphthirus trichechi* (Boheman), has been taken from the Pacific walrus in Behring Sea, Alaska.

The fur seal louse, *Antarctophthirus callorhini* Osborn (*A. monachus* Kellogg and Ferris), occurs on the Alaska fur seal.

[1] See note 2, p. 197.

CHAPTER XXI

HOMOPTERA.[1] (Order)

(*Homos*, same; *pteron*, wing)

Harvest Flies, Spittlebugs, Treehoppers, Leafhoppers, Psyllids, Aphis, Scale Insects, White Flies

The order Homoptera, comprises a very large group of diversified insects difficult to characterize collectively. They are small, delicate, winged or apterous, with simple (or rarely complex in male scale insects) metamorphosis, and sucking mouth parts. As the order name suggests, the wings are usually of the same size and texture although in many the fore wings are somewhat thicker and often pigmented. At rest they are folded roof-like over the body. All are plant feeders, the order being one of the most injurious to plant life. Many species excrete over the plants quantities of honeydew, a sweet sticky material, upon which often grows a black smut fungus, and which causes smutting of fruit and foliage. Because of the great differences in the habits and economic relationships, the natural enemies and control measures will be discussed under the different families. The order is so large that only the more interesting and important members can be included in this work.

KEY TO FAMILIES

1. Tarsi 3-jointed, antennæ very short, with a terminal bristle; beak plainly arising from the head; active, free living insects 2
   Tarsi 1- or 2-jointed, antennæ usually well developed, sometimes wanting, without terminal bristle; beak appearing to arise between the front legs, rarely absent in the male; females stationary or of slow movement 6

2. Large insects with three ocelli; males with musical organs and are loud shrill singers (Cicadas, Harvestflies) .... **Cicadidæ** p. 200
   Small insects normally with two ocelli, rarely three or more or wanting; males without musical organs 3

3. Antennæ inserted on side of cheek beneath the eyes (Lanternflies) .. **Fulgoridæ** p. 217
   Antennæ inserted in front of and between the eyes 4

4. Prothorax prolonged backwards over the abdomen (Treehoppers) **Membracidæ** p. 203
   Prothorax not prolonged backwards over the abdomen 5

5. Hind tibiæ armed with two stout teeth and tip with a circle of small, stout spines (Spittlebugs) .... **Cercopidæ** p. 202
   Hind tibiæ with a double row of spines (Leafhoppers) .... **Cicadellidæ** p. 206

[1] In older writings this order has been considered as a suborder of *Hemiptera*, which is now replaced by the three orders *Anoplura*, *Homoptera*, and *Heteroptera*.
E. P. Van Duzee, "Catalogue of *Hemiptera*." *Univ. Calif. Pub. Tech. Bul. Entomology*, 2, 1917. Complete Catalogue and Bibliography.
More complete references under Family headings.
E. P. Van Duzee has read the manuscript of this order and has made a number of corrections and valuable suggestions.

6. Tarsi 1-jointed with single claw, females sometimes legless, of many forms, often covered with a scale or with waxy material; males 2-winged (Scale Insects).. **Coccidæ** p. 264
   Tarsi 2-jointed; wings two pairs or wanting.................................. 7
7. Wings covered with fine white powdery wax(Whiteflies, Mealywings). **Aleyrodidæ** p. 322
   Wings transparent or not covered with wax.................................. 8
8. Legs normal; antennæ 3- to 7-jointed (Aphis or Plant Lice) (Superfamily)....... **Aphidoidea** p. 223
   Hind legs enlarged for jumping; antennæ 9- to 10-jointed (Psyllids). **Chermidæ** p. 218

CICADIDÆ.[1] Harvest Flies or Cicadas.

The cicadas or harvestflies are medium to large insects which are characterized by having the proboscis arising plainly from the head, three ocelli, small, bristle-like antennæ, 3-jointed tarsi, musical organs in the male, and two pairs of many-veined membranous wings. The males are shrill singers and their continuous song is heard on bright, hot, spring and summer days, and gives rise to the name harvest flies. They are much more abundant in the Eastern States where the periodical cicada or seventeen-year locust is a regular visitor. The western species are mostly smaller and, while common, are never present in great numbers. The eggs are normally deposited in small twigs, punctures being first made by the sharp ovipositor for their insertion. The only apparent damage done is the killing of the twigs in making these egg punctures. The eggs hatch within a few days and the nymphs make their way into the ground, where they remain one, two, or more years depending on the species, the seventeen-year locust requiring seventeen years of subterranean life before the nymphs crawl out and pass into the adult stage. The nymphs probably feed on the roots of grasses and other plants but their work is so obscure as to be unnoticeable. The nymphs leave the ground and crawl up on some object prior to the emergence of the adult. Very little is known concerning the life histories of any of our many western species. A few of the most interesting are described.

The girdled cicada, *Tibicen cinctifera* (Uhler) (*Cicada*), has brown head and thorax and black abdomen, and is 25 mm. long. It is of interest because it so often oviposits in the twigs of fruit trees and other plants, such as citrus, olive, peach, and other deciduous trees; ash, rose, cotton, and so forth. Young nursery stock and olive trees suffer most. It occurs in California, Arizona, and New Mexico.

The grand cicada, *Tibicen dorsata* (Say) (*Cicada*), is according to Uhler "the grandest and most beautiful of the large western cicadas." It is common in Colorado and also occurs in Arizona, New Mexico, and the States to the east of the Rocky Mountains.

The Montezuma cicada, *Tibicen montezuma* (Distant) (*Cicada*), is orange and black with tan and white markings, and 26 mm. long. It frequents the plains and mesas of Southern California, Arizona, New Mexico, Texas, and Mexico, and according to C. H. T. Townsend [2] frequents and feeds on yucca.

[1] In many localities these insects are wrongly called locusts, a term more appropriately used for short-horned grasshoppers.
P. R. Uhler, *Trans. Md. Acad. Sci.*, 1, 1892.
W. T. Davis, "New Spp. *Cicadidæ* Chiefly from the Western States." *Jour. N. Y. Ent. Soc.*, 23, 1915, p. 11; 24, 1916, pp. 42, 233; 25, 1917, p. 6; 27, 1919, pp. 68, 179; 28, 1920, p. 95; 29, 1921, pp. 1, 43.
E. P. Van Duzee, "West Coast *Cicadidæ*." *Jour. N. Y. Ent. Soc.*, 23, 1915, p. 21. *Cat. Hemiptera*. Univ. Cal. Pub., Ent. 2, 1917, p. 487.
R. E. Snodgrass, "Mouthparts of *Cicadidæ*." *Proc. Ent. Soc. Wash.*, 23, 1921, p. 1.
[2] *Can. Ent.*, 24, 1892, p. 195.

Townsend's cicada, *Tibicen townsendi* (Uhler) (*Cicada*),[1] oviposits in the twigs of pear, plum, and other fruit trees of New Mexico. It also occurs in California, Arizona, and Texas, and frequents the valleys.

The crackling cicada, *Cacama crepitans* (Van Duzee) (*Proarna*), is a dark species 22 mm. long with a few conspicuous, whitish spots on the body, and on the veins at the bases of the wings orange or reddish. It is a most interesting species which inhabits the coastal hills of Southern California occurring chiefly on California sage. The song of the male is long and almost deafening and when captured the sound is suddenly changed to shrill, high-pitched notes. It is most abundant during the forenoons on warm or hot July days.

The large grass cicada, *Okanagana consobrina* Distant,[2] is from 25 to 30 mm. long, and black and tan with veins at bases of wings reddish or orange. The males sing almost continuously in the dry grass of the fields and hillsides on hot June and July days in the foothill regions of California.

The bloody cicada, *Okanagana cruentifera* (Uhler) (*Tibicen*), is 30 to 32 mm. long, and black throughout. It does some damage to fruit trees in Montana. It is also reported in Colorado, Nevada, and California.

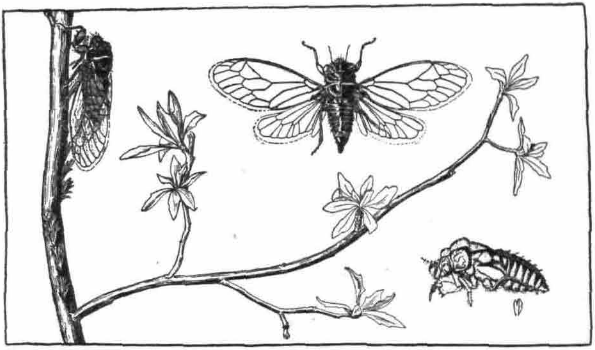

FIG. 103.—The minor cicada, *Platypedia minor* Uhler. Adults, egg punctures and cast skin of last nymphal stage.

The small grass cicada, *Okanagana minuta* Davis, is 16 mm. long. The color varies from straw or tan to black or a combination of these colors, and with orange or pink blotches at the bases of the wings. It is often abundant in the dry grass in the hills of the Coast Range Mountains of Central California and may be associated with the large grass cicada which it resembles in song and habit.

The Napa cicada, *Okanagana napa* Davis, is from 30 to 35 mm. to the tips of ths wings, and black and tan in color. It is a loud, shrill singer in the oak and other tree and shrubs on the dry hillsides of the Coast Range Mountains of Central California.

The red-winged grass cicada, *Tibicinoides cupreosparsus* (Uhler) (*Tibicen*), is a small robust brownish or blackish species 20 mm. long, with the bases of the wings bright red. It inhabits the dry grassy areas in Southern California and may be mistaken for the large and small grass cicadas which it resembles in color and habits. The males make a feeble noise of long duration.

[1] Listed by Townsend as *T. ochreoptera* (Uhler). *Insect Life*, 5, 1892, p. 80.

[2] This species was described as a variety of *O. vanduzeei* by Distant, but is now considered a valid species by E. P. Van Duzee.

The bella cicada, *Okanagana bella* Davis, has the surface polished blue-black with orange-fulvous markings, and is about 24 mm. long. It is a widely distributed western species having been recorded in British Columbia, California, Nevada, Utah, and Colorado.

The orchard cicada, *Platypedia areolata* (Uhler) (*Cicada*),[1] is about 18 mm. long bronzy-blackish with yellow and amber markings and a conspicuous greenish-yellow band between the prothorax and mesothorax. It is a common western species and very often oviposits in the twigs of many kinds of deciduous fruit and olive trees. It occurs in British Columbia, Washington, Oregon, California, Nevada, Utah, Idaho, and Montana. The var. *similis* Davis occurs in the San Francisco Bay Region.

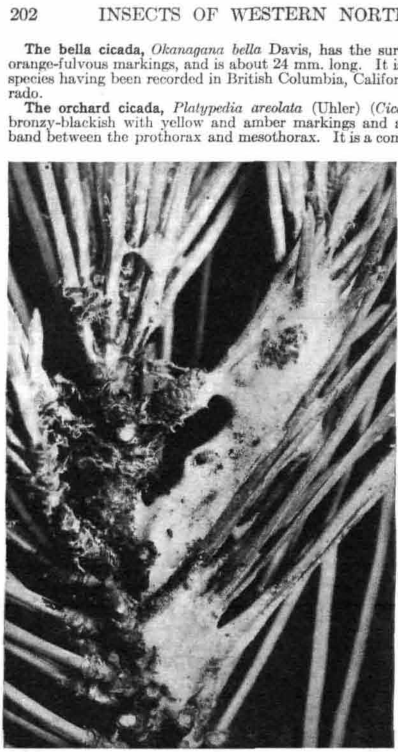

FIG. 104.—Spittle or froth of a spittlebug on pine.

The minor cicada, *Platypedia minor* Uhler (Fig. 103), is of much the same size and color as the orchard cicada, but lacks the pale band on the thorax. It is much more abundant in California and oviposits chiefly in twigs of native oak, baccharis, madrona, and willows, as well as in fruit trees. It is most abundant in trees on open, grassy slopes or along creeks, and fairly fills the air on hot days with the characteristic short, sharp clicks, repeated four or five times.

Putnam's cicada, *Platypedia putnami* (Uhler) (*Cicada*), much resembles the latter in appearance and habits. It is common in the Western States and oviposits in native trees and shrubs and in deciduous fruit trees. It is abundant along creek beds. The males make eight clicks, rapid at first and then slower. Several varieties are recognized by Davis[2] as follows: *occidentalis* Davis, in Northern California; *keddiensis* Davis, in Oregon and Northern California; *lutea* Davis, in Montana, Wyoming, Utah, and Arizona.

CERCOPIDÆ.[3] Spittlebugs, Froghoppers.

The spittlebugs or froghoppers are so called from the fact that the nymphs are often surrounded with and live in a mass of white froth or spittle (Fig. 104); and also because of the squatty, frog-like appearance of

[1] E. O. Essig, *Inj. and Ben. Ins. Calif.*, 2d ed. 1915, p. 60.
[2] W. T. Davis, *Jour. N. Y. Ent. Soc.*, 28, 1920, pp. 106, 108.
[3] E. D. Ball, "Adaptations to Arid Conditions in *Cercopidæ*." *Ann. Ent. Soc. Am.*,

the adults. The antennæ are minute and bristle-like, the mouth parts arise plainly from the head, and the tarsi are three-jointed. They feed on grasses, succulent vegetation, and herbaceous plants, extracting the juices as do other members of this family. There is a single generation annually, the adults hibernate and the nymphs appear in spring and early summer. The spittle or froth surrounding the nymphs conceals and protects them from parasitic and predaceous enemies and is a unique adaptation.

The rhubarb spittlebug, *Aphrophora permutata* Uhler (Fig. 105), is 8 to 10 mm. long and mottled brown in color. It is a very common western species, the froth-covered nymphs occurring in moist places on rhubarb, dock, dandelions, poppies, lettuce, and many other plants, and the adults may be collected in sweeping such areas, or on shrubs. It occurs in Washington, Oregon, California, Idaho, Montana, Nevada, Utah, Colorado, and New Mexico. Although quite abundant it has never been a pest.

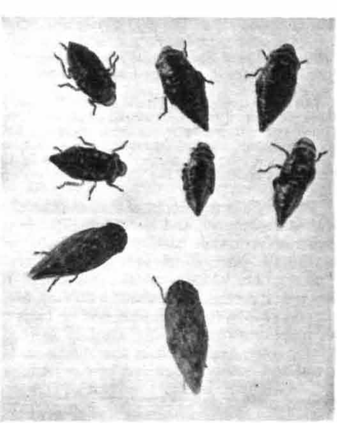

FIG. 105.—The rhubarb spittlebug, *Aphrophora permutata* Uhler. Nymphs and adults.

The annulate spittlebug, *Aphrophora annulata* Ball, was taken by Ball[1] around the crown of western mugwort in Utah, and *Philaronia abjecta* (Uhler), on the roots and crowns of lupine and geranium in the mountains of Colorado. The latter species has a wide distribution, having also been found in Alaska, Utah, Arizona, and east of the Rocky Mountains in the United States and in Canada.

The ceanothus spittlebug, *Clastoptera obtusa* (Say) (*Cercopis*), is pale fawn with paler and darker maculations, short and robust, and 4 to 5 mm. long. The nymphs live on ceanothus in globular white or discolored masses of stiff, felt-like froth, which are just large enough to accommodate the inhabitant. Three varieties, *achatina* Germ., *testacea* Fitch, and *tristis* Van D., are recognized by Van Duzee; and two varieties, *borealis* Ball, in Eastern United States, and *juniperina* Ball, on red cedar in Colorado, by Ball. The species occurs throughout North America. In the west it is recorded in Colorado, New Mexico, and California. Nymphs and adults were taken by the writer in Yosemite Valley, California.

MEMBRACIDÆ.[2] Membracids, Treehoppers.

The treehoppers are small, queer-looking insects characterized by the enlarged and prolonged prothorax which projects above the head and

8, 1915, p. 365. "Notes on *Cercopidæ* and N. Spp." *Iowa Acad. Sci.*, 26, 1916, p. 143.

Herbert Osborn, *Studies of Life Histories of Froghoppers of Maine*. Bul. 254, Maine Agr. Exp. Sta. 1916.

E. P. Van Duzee, *Univ. Cal. Pub. Tech. Bul. Ent.*, 2, 1917, p. 507. Cat. and Complete Bibliography.

Philip Garman, *The Grass Feeding Froghopper or Spittlebug*. Bul. 230. Conn. Agr. Exp. Sta. 1921. (Not western.)

[1] E. D. Ball, *Ann. Ent. Soc. Am.*, 8, 1915, p. 365.

[2] F. W. Goding, "Syn. Subfamilies and Genera *Membracidæ* N. A." *Trans. Am.*

extends back over the abdomen. The antennæ are minute, bristle-like, the beak is plainly inserted in the head, and the tarsi are 3-jointed. The adults hop and fly readily. The eggs are inserted in the bark of various trees in straight or cresent-shaped slits which may be definitely arranged or in great confusion so as to completely scar the bark where they remain during the winter, hatching in the spring. The young nymphs are narrow, flattened laterally, and often have a fringe of hairs or spines along the eave-like back. All are sap feeders and puncture the plants to suck out the jucies. The name treehopper is somewhat misleading since the members are as likely to be found on small shrubs and grasses as on trees. The winter is passed in the egg, nymph or adult stage.

The pale treehopper, *Ceresa albido-sparsa* Stål, is a pale green species 8 mm. long with short, curved, red-tipped lateral pronotal horns. It is common in California and Nevada.

The basal treehopper, *Ceresa basalis* Walker, is pale green or greenish-yellow with the under side of the body black, 7 to 8 mm., with two lateral horns on the pronotum tipped red. It is the commonest species in British Columbia, occurring on willow, goldenrod, and weeds. In Oregon it oviposits in apple trees. It is also recorded in California, Utah, New Mexico, and Eastern States feeding on goldenrod and cultivated plants. It undoubtedly has a much wider western distribution.

The buffalo treehopper, *Ceresa bubalus* (Fabricius) (*Membracis*),[1] is the widest distributed and best known treehopper in this country. It is bright green or yellowish with the underside yellowish. The horns on the pronotum are short, stout, and point directly outward. The length is 10 mm. The eggs are white, smooth, cylindrical, rounded at one end and tapering towards the other, and about 0.80 mm. long. They are inserted in crescent-shaped slits in the bark in series of twos opposite each other so as to form an indefinite oval. They are laid in the fall in September and October, winter over, and hatch in the spring in May and June. The nymphs are green and easily recognized by the large, spiny processes on the back.

The eggs are laid in the bark of stems of two- or three-year-old wood of fruit trees, chiefly apple, pear, cherry, prune, and so on, and in elm, thorn, willow, maple, and other native and ornamental trees. The nymphs and adults feed on foliage of succulent plants, shrubs, and trees including sweet clover, alfalfa, goldenrod, aster, wild licorice, potato, tomato, lily, grasses, apple, almond, apricot, grape, peach, pear, plum, locust, willow, and so forth. It occurs throughout the country and is reported in all the Western States. It is sometimes a pest to nursery stock and young fruit trees, injuring or even killing the same by making numerous egg-punctures, and is particularly serious in orchards interplanted with alfalfa, cover crops, or those in which weeds are allowed to grow during the spring and summer months. The most practical method of control is clean culture in and

Ent. Soc., 19, 1892, p. 253. "Biblio. and Synopt. Cat. *Membracidæ* N. A." Bul. 3, *Ill. State Lab. Nat. Hist.*, 1894, p. 391.

E. P. Van Duzee, "Studies in N. A. *Membracidæ*." Bul. 9, *Buffalo Soc. Nat. Sci.*, 1908, p. 29. "Cat. *Hemiptera* of Am. No. of Mexico." *Univ. Cal. Pub. Tech. Bul. Ent.*, 2, 1917, p. 520. Bibliography and Catalogue.

W. D. Funkhouser, "Hom. of Wing Veins of *Membracidæ*." *Ann. Ent. Soc. Am.*, 6, 1913, p. 74. "Biol. of *Membracidæ* of Cayuga Lake Basin." *Memoir* 11, Cornell Univ. Agr. Exp. Sta., 1917.

[1] W. D. Funkhouser, *Mem.*, 11, Cornell Univ. Agr. Exp. Sta. 1917, p. 219.

around the nurseries and orchards. The red mite, *Eupalus echinatus* Banks,[1] attacks the adults in Colorado.

The western treehopper, *Ceresa occidentalis* Funkhouser, is a small, bright green species, 6.5 mm. long, with short, stout horns. It has been taken in large numbers in alfalfa fields of Imperial County, California, by the writer and probably also occurs in Arizona and neighboring States.

The three-cornered alfalfa hopper, *Stictocephala festina* (Say) (*Membracis*),[2] is a small, bright green species, 5 mm. long and without pronotal horns. It is abundant and injurious in alfalfa fields in Southern California, Arizona, and New Mexico, and also attacks weeds, forage crops, and fruit trees, and oviposits in alfalfa stems. The distribution is general and also includes Colorado and Montana in the west as well as many other parts of the United States. Two varieties: *rufivitta* (Walker) and *angulata* Van Duzee are recognized. The hymenopterous parasites *Gonatocerus ornatus* Gahan, *Polynema imitatrix* Gahan, and *Abbella (Ittys) perditrix* Gahan have been reared from eggs in Arizona.[3]

The green clover hopper, *Stictocephala inermis* (Fabricius) (*Membracis*),[4] is a large, uniform green or reddish, hornless species, 7 to 9 mm. long. It is common on, and often injurious to grasses, alfalfa, clover, sweet clover, oats, and other forage plants and weeds. The egg-punctures are made in apple, peach, plum, and other fruit trees, and have been injurious to nursery stock. The species is widely distributed throughout the United States and is recorded in the west in Oregon, California, Nevada, Montana, Colorado, New Mexico, and Arizona.

The Pacific treehopper, *Stictocephala pacifica* Van Duzee, is green throughout in the females and green with black venter in the males. There are no pronotal horns. It is common on willow in British Columbia [5] and also occurs in California.

Wickham's treehopper, *Stictocephala wickhami* Van Duzee, is a bright green, hornless species. It occurs on many shrubs, grasses, weeds, and cultivated plants, and is often abundant on willow and sunflower. It occurs in California and Washington.

The modest treehopper, *Pubilia modesta* Uhler (*P. bicinctura* Goding), is yellow mottled with brown, with or without white bands and ferruginous color, 5 mm. long. It is reported injurious to chrysanthemums in New Mexico.[6] It also occurs on mesquite, wild licorice, and other plants. Like some other species it is often found in the dry seasons at the bases or on the roots of the host plants.[7] This species also occurs in Colorado, Utah, Arizona, and California.

The oak treehopper, *Platycotis vittata* (Fabricius) (*Cercopis*) (Fig. 106), is a beautiful dull olive or sea green or bronzy species 10 mm. long, with the surface finely punctured and with red dots, the median pronotal horn long, short, or wanting, and with two lateral horns. The variety *quadrivittata* (Say) is pale bluish with four red longitudinal stripes and usually with median and lateral pronotal horns well developed. The nymphs are black with yellow and red markings and with two prominent soft black spines on the middle dorsum. The normal food plants consist in a wide variety of deciduous and evergreen oak trees, in the small twigs of which the eggs are inserted. In one instance the author took a freshly hatched colony from a cultivated chestnut tree. The young are gregarious and often occur in compact colonies. This is a widely

[1] C. P. Gillette and C. F. Baker. *Cat. Hemip. Colo.* 1895, p. 66.
[2] V. L. Wildermuth, *Jour. Agr. Research*, 3, 1915, p. 343.
[3] A. B. Gahan, *Proc. Ent. Soc. Wash.*, 20, 1918, p. 23.
[4] W. D. Funkhouser, *Mem.* 11, Cornell Univ. Agr. Exp. Sta. 1917, p. 233.
[5] W. Downes, *Proc. B. C. Ent. Soc.*, 1919, p. 17.
[6] T. D. A. Cockerell, Bul. 19, N. Mex. Agr. Exp. Sta. 1896, p. 102.
[7] E. D. Ball, *Ann. Ent. Soc. Am.*, 8, 1915, p. 368.

distributed species throughout the country. In the west it is recorded in British Columbia, California, and Arizona, where the striped variety is predominant. *P. minax* Goding, is a very much smaller, dull brown species with abbreviated or well developed pronotal horns. It is common on oak throughout California.

The wide-footed treehopper, *Campylenchia latipes* (Say) (*Membracis, C. curvata* Stål), is cinnamon brown, and has a front, deeply keeled pronotal horn and two lateral ridges on the pronotum, which is densely punctured and hairy. The length is 6 mm. It

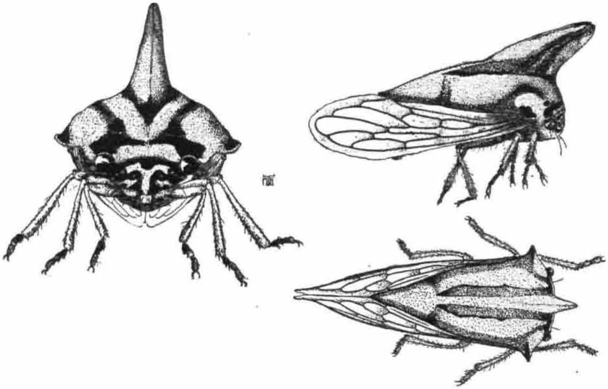

FIG. 106.—The oak treehopper, *Platycotis vittata* (Fabr.). (After Woodworth.)

infests a variety of grasses, weeds, shrubs, and forage plants including wild licorice, *Psoralea, Apocynum*, alfalfa, clover, goldenrod, and so on, and may occur at the crown and on the roots as well as on the tops. It occurs throughout the United States and Canada and is reported in the west in Montana, Wyoming, Colorado, New Mexico, Arizona, and California.

CICADELLIDÆ (JASSIDÆ.)[1] Leafhoppers, Sharpshooters.

The members of this large family are small, slender insects with minute, bristle-like antennæ inserted in front of and between the eyes; usually

[1] This family has commonly been known as *Tettigonidæ or Jassidæ* in past years.
E. P. Van Duzee, "Superfamily *Jassoidea*." *Trans. Am. Ent. Soc.*, 19, 1892, p. 295. 21, 1894, p. 245. *Check List Hemiptera*. 1916, p. 63. "Cat. *Hemiptera*." *Univ. Cal; Pub. Tech. Bul. Ent.*, 2, 1917.
C. P. Gillette, "American *Typhlocybinæ*." *Proc. U. S. Nat. Mus.*, 20, p. 709, 1898.
H. Osborn, "*Jassidæ* of N. Y." *Univ. Bul.* 22, Ser. 9, No. 24. Ohio State Univ. 1905. Bul. 108, Bur. Ent. U. S. Dept. Agr. 1912. *Life Histories of Leafhoppers of Maine*. Bul. 248, Maine Agr. Exp. Sta. 1916.
Z. P. Metcalf, "Wing Venation of *Jassidæ*." *Ann. Ent. Soc. Am.* 6, 1913, p. 103.
D. M. Delong, *The Leafhoppers or Jassoidea of Tennessee*. Bul. 17, Tenn. State Bd. Ent. 1916.
F. H. Lathrop, *The Cicadellidæ or Leafhoppers of South Carolina*. Bul. 199, S. C. Agr. Exp. Sta. 1919.
P. B. Lawson, "The *Cicadellidæ* of Kansas." *Kan. Univ. Sci. Bul.*, 12, No., 1, Ent. 4, March 15, 1920.

with two ocelli; the hind tibiæ with a double row of spines, the chief distinguishing characteristic of the family. The front wings are somewhat thickened and often brightly colored to match the head and prothorax. As the common names imply, they are active jumpers, although the adults also fly freely. Both young and adults have the characteristic habit of running sidewise. All are plant feeders, and pierce and suck out the juices causing a drying-up and wilting of the tissues. In addition many species are carriers of plant diseases such as hopperburn, tipburn, curly leaf, blight, mosaic, and bacterial and fungous diseases, and cause great losses to certain agricultural crops. The winter is usually passed in the egg stage although in many species adults and, in a few, nymphs hibernate in grasses, weeds, or trash. The small, whitish, elongate, slightly curved eggs are inserted in tender plant tissues in the spring and the wingless nymphs after four or five molts grow to maturity in 18 to 50 days so that from one to six broods may appear before the next winter. Of the large number of known species the great majority feed upon wild grasses, weeds, flowers, shrubs, and trees. A number of native species have also gone over to cultivated plants and are now serious pests, while a few are introduced, old world species of well known destructive habits.

The natural insect enemies consist of parasites of the eggs, nymphs, and adults, and the predaceous green lacewings, raphidids, bugs, ladybird beetles, wasps, and a host of others which are responsible for more good in destroying these pests than is generally believed. They will be referred to more specifically under the different species.

Control measures consist largely of the use of the milder contact insecticides in the form of dusts and liquids directed against the nymphal stages when the insects are unable to fly. Of the dusts a five per cent nicodust is sufficient to kill the nymphs of most of the species, while a ten per cent nicodust kills both the nymphal and adult stages. Calcium cyanide dust is relatively new, but field tests have shown that a 25 per cent dust is very effective in killing the leafhoppers with little or no injury to the plants, if applied when the latter are free from moisture. Sprays composed of the following are also effective against the nymphs:

Whale oil soap	10 lbs.
Nicotine sulfate, 40%	1 pint
Water to make	200 gals.

This formula can be modified without seriously reducing its efficiency by substituting two gallons of miscible oil for the nicotine sulfate or by simply using the soap and water without either the nicotine or the miscible oil. On very tender plants it is advisable to use only the nicotine and the water, omitting the soap and the miscible oil. The leafhoppers usually feed on the undersides of the leaves so that care must be exercised to apply the dusts and sprays in such a manner as to reach all parts of the plants.

F. A. Fenton, "The Parasites of Leafhoppers." *Ohio Jour. Sci.*, 18, pt. 1, pp. 177, 285, pt. 2, p. 243, 1918.

W. L. McAtee, "Key to Nearctic Species and Varieties of *Erythroneura*." *Trans. Am. Ent. Soc.*, 46, 1920, p. 267.

E. D. Ball, "A Rev. of Genus *Gypona* of N. A. No. of Mex." *Ann. Ent. Soc. Am.*, 13, 1920, p. 83.

BYTHOSCOPINÆ. (Subfamily) Short Leafhoppers. **The four-spotted leafhopper,** *Agallia 4-punctata* (Provancher) (*Bythoscopus*), varies from yellowish or dark brown to gray with two dark spots on the head and two on the pronotum. It is a large, robust species, 4 mm. long, which feeds on alfalfa, beet, horseradish, sunflower, and various weeds. The range is wide, Colorado, British Columbia, Northern California (U. S.). *Agallia oculata* Van Duzee is common on elderberry in Southern California.

The clover leafhopper, *Aceratagallia sanguinolenta* (Provancher) (*Bythoscopus, Agallia*),[1] is a short, broad, flattened species 3 mm. long, and light gray with light and dark markings giving it a mottled appearance. The adults hibernate and become active on warm winter days. The nymphs appear in early spring. It is often a serious pest of leguminous crops as clover, lupines, peas, vetch, and alfalfa, but also infests grasses, grains, corn, beets, cabbage, weeds, and wild flowers. It occurs throughout the United States and is reported from the west in British Columbia, Washington, Oregon, California, Nevada, Utah, Wyoming, Colorado, Arizona, and New Mexico.

Uhler's leafhopper, *Aceratagallia uhleri* (Van Duzee) (*Agallia*), is similar to the clover leafhopper in color and about the same size, but is not so broad and flat and has the elytra much longer. It is often abundant and injurious to alfalfa, beets, grasses, and native weeds, shrubs, and flowers in Colorado, Wyoming, New Mexico, Arizona, and California (U. S.).

The following are common willow leafhoppers occurring throughout the country: *Idiocerus alternatus* Fitch is 5 to 5.25 mm. long and brownish in color. It occurs in Colorado, Utah, California; *I. nervatus* Van Duzee is 4.5 to 4.75 mm. long, pale greenish or yellowish and is found in Colorado, Arizona, and California. *I. pallidus* Fitch is from 6 to 6.25 mm. long, pale green often with the elytra dusky-tipped, and occurs in Colorado and California. *I. suturalis* Fitch is 5 to 5.75 mm. long, pale yellow with brown markings, and is reported from Colorado and New Mexico.

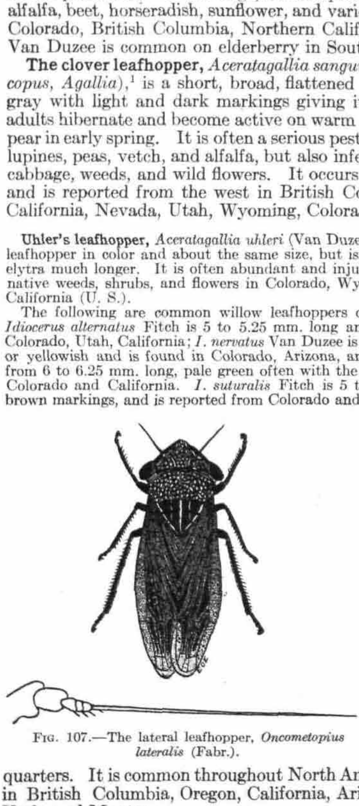

FIG. 107.—The lateral leafhopper, *Oncometopius lateralis* (Fabr.).

CICADELLINÆ (Subfamily). The Sharpshooters. **The lateral leafhopper,** *Oncometopius lateralis* (Fabr.) (*Cercopis*) (Fig. 107), is a dark species; the head, pronotum, and scutellum are black specked with yellow; the elytra are reddish or dull bluish, with black veins and frequently with yellow margins; the legs are black. The length varies from 7 to 8 mm. The normal food plants are grasses and weeds, but it readily attacks cultivated crops and has been taken on apple, cotton, corn, potato, onion, parsnips, and lambsquarters. It is common throughout North America. In the west it is known in British Columbia, Oregon, California, Arizona, New Mexico, Colorado, Utah, and Montana.

[1] H. Osborn, Bul. 108, Bur. Ent. U. S. Dept. Agr. 1912, p. 103.

The blue sharpshooter, *Cicadella circellata* (Baker) (*Tettigonia, Tettigoniella*) [1] (Fig. 108), is a beautiful, slender, blue or bluish green iridescent species with the head, pronotum, scutellum, legs, and venter yellow or orange. There are some very characteristic black lines and spots on the dorsum of the head, pronotum, and scutellum. The length is from 6 to 7 mm. This species is common and often abundant in California on many native plants and is known to occur on grasses, grape, blackberry, raspberry, orange, lemon, hollyhocks, sunflower, elder, cocklebur, and so forth. It also occurs in Arizona and probably in many other Western States.

FIG. 108. — The blue sharpshooter, *Cicadella circellata* (Baker).

The hieroglyphic sharpshooter, *Cicadella hieroglyphica* (Say), is rather stout, 6 to 7 mm. long, from brick red to green or dull blue, with prominent black markings on the vertex of the head. It is common throughout North America and occurs in all of the Western States. Three varieties, *dolborata* (Ball), almost black; *uhleri* (Ball), reddish or greenish; and *confluens* (Uhler) are recognized. The normal food plants are willow and alder.

The bog leafhopper, *Helochara communis* Fitch, is a small green form with dark or dusky markings on face, and from 4 to 7 mm. long. The surface is distinctly punctate. It is often very abundant in moist places and feeds on swamp grasses, rushes (*Juncus*), willow, and so forth. It is common in the United States and is reported from California, Arizona, New Mexico, and Colorado in the west.

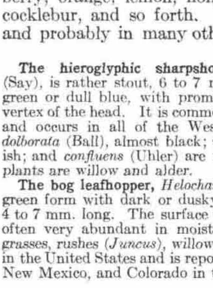

FIG. 109. — The sharp-headed grain leafhopper, *Draeculacephala mollipes* (Say).

The sharp-headed grain leafhopper, *Drœculacephala mollipes* (Say) (*Tettigonia*) [2] (Fig. 109), is a long, slender, bright green species with the head, pronotum, and scutellum yellow, and legs green. The length varies from 6 to 9.5 mm. The head is sharply pointed, and the vertex is longer than the pronotum and is marked with oblique, brownish lines. The winter is spent in the adult stage, the hibernating forms being darker green or brownish. The eggs are laid in the spring and summer under the epidermis along the margins of the grass leaves. There are two generations annually. The nymphs and adults are often so numerous as to cause considerable damage to young grain crops. The normal food plants are grasses, but barley, oats, rye, wheat, alfalfa, clover, corn, timothy, sorghum, cowpeas, vetch, and so forth, are also infested. The species is common throughout North America and occurs in certain

[1] P. B. Lawson has placed his species as a synonym of *C. atropunctata* (Signoret). *Sci. Bul. Univ. Kan.*, 12, Mar. 15, 1920, p. 87.
E. O. Essig., *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 66.

[2] E. H. Gibson, Bul. 254, *Prof. Paper*, U. S. Dept. Agr., 1915.

localities in the west. The fungus, *Empusa grylli* Fres., kills nymphs and adults under certain damp conditions.

The small, sharp-headed leafhopper, *Draeculacephala minor* (Walker),[1] is much like the above but is smaller, 6 mm. long, has the vertex shorter than the pronotum, and the entire venter of the male dull black. It occurs often in great numbers on grasses and other plants, often in company with the larger species. It occurs in Washington, California, Colorado (Florida).

The grass sharpshooter, *Draeculacephala noveboracensis* (Fitch) (*Aulacizes*), is much like *D. mollipes* (Say), but is paler in color, with shorter and blunter head and more distinct spots on the vertex. It feeds on grasses in moist localities and occurs in British Columbia, Washington, Idaho, Colorado (U. S., Canada).

The yellow-headed leafhopper, *Draeculacephala reticulata* (Signoret), is a small, pale green species 4 to 5.5 mm. long, with the head bright yellow or orange and lacking the dusky markings on the vertex found in the preceding forms. It is a grass feeder which also attacks oats, wheat, barley, and so on, and is limited in the west to California, Arizona, and New Mexico, but also occurs in other States and in Lower California and Mexico.

GYPONINÆ (Subfamily). The Robust Leafhoppers. **The angulate leafhopper,** *Gypona angulata* Spnågberg, is a broad, bright yellow, pale green or nearly white species 8 mm. long, reported attacking alfalfa in New Mexico by C. H. T. Townsend.[2] It also occurs in Colorado, Utah, California (Texas).

The 8-lined leafhopper, *Gypona 8-lineata* (Say), is a beautiful, large, oval, pale green species with six yellowish or red longitudinal lines on the vertex, eight on the pronotum and four on the scutellum. The nervures of the elytra are yellow or red. The length is from 7 to 10 mm. The nymphs are orange in color. It is a common eastern species said to be in every section of the United States by E. H. Gibson.[3] H. F. Wilson reports it injurious to loganberry plants in Oregon.[4] Other hosts are willow, birch, maple, beech, dogwood, oak, walnut, apple, blackberry, aster, dahlia, sugar beet, grasses, shrubs, and weeds.

The green flat-headed leafhopper, *Xerophlœa viridis* (Fabr.) (*Cercopis*), is robust, wedge-shaped, and is 6 to 7.25 mm. long. The head is flat and the tips of the elytra at rest are perpendicular rather than horizontal. The color is bright green with the elytra paler toward the apices. It is often abundant on native grasses in Washington, Oregon, California, Utah, and Colorado (U. S.).

JASSINÆ (Subfamily). The Variable Leafhoppers. **The sharp-nosed leafhopper,** *Platymetopius acutus* (Say) (*Jassus*), has the vertex sharp-pointed, yellowish specked with brown; the pronotum, scutellum, and elytra, brown marked with whitish lines and spots; the venter, black marked with whitish. It is a small species 4.5 to 5 mm. long. It normally feeds on grasses but also attacks alfalfa and clover. It is general throughout the country and is known in British Columbia, Utah, Colorado, New Mexico, and Arizona. A variety *dubius* Van Duzee occurs in the chapparal of Southern California.

The yellow-faced leafhopper, *Platymetopius frontalis* Van Duzee, is short and stout, 3.5 to 4 mm. long, dark brown or black with yellow face and white spots on the head and elytra. It is a common eastern species reported only from California in the west. It feeds on rank grasses, clover, and weeds, growing in the shade.

The kindred leafhopper, *Deltocephalus affinis* Gillette and Baker, varies from pale ashy green to brownish gray, pronotum often mottled with

[1] This species is listed as a variety of *D. mollipes* (Say) by some writers.
[2] *Can. Ent.*, 24, 1892, p. 196.
[3] *Proc. U. S. Nat. Mus.*, 56, 1920, p. 90.
[4] *Second Bien. Crop. Pest & Hort. Rept.*, 1913–1914, Ore. Agr. Exp. Sta. 1915, p. 202.

fuscous, and sometimes with five pale, longitudinal stripes. The length varies from 3 to 4 mm. It normally feeds on blue grass and other grasses, but also attacks oats and wheat. It occurs throughout North America and is reported from British Columbia, California, and Colorado in the west.

The inimical leafhopper, *Deltocephalus inimicus* (Say) (*Jassus*),[1] is somewhat robust and from 2.75 to 5 mm. long. The color is grayish or pale fuscous marked with brown or black, and with a pair of black spots on the vertex, a pair on the pronotum and a third pair on the scutellum. The nymphs are pale with the lateral margins of the thorax and abdomen dark. The eggs are deposited in the leaf or stem of the host in the fall and do not hatch until the following spring. It is a widely distributed and injurious species occurring throughout northern United States and Canada, and is known in British Columbia, Washington, Oregon, Idaho, Montana, Wyoming, and Colorado. It feeds on many kinds of grasses, timothy, barley, oats, wheat, rye, millet, corn, alfalfa, clover, and similar plants. The dryinids, *Gonatopus erythrodes* (Perkins) and *G. inimicus* Fenton, prey on nymphs and adults in Ohio.

The destructive leafhopper, *Euscelis exitiosus* (Uhler) (*Cicadula exitiosa* Uhler, *Limotettix*), is from 3.5 to 5.5 mm. long, pale yellowish or whitish with black and brown spots and markings and with distinct brown nervures in the whitish elytra. It is widely distributed in North America and is reported in Arizona, Colorado, and California in the west. It may often be present in swarms and is destructive to grasses and grains.

The sugar beet leafhopper, *Eutettix tenellus* (Baker) (*Thamnotettix*)[2] (Fig. 110), is a small species from 3 to 3.5 mm. long and variable in color from pale green in the spring to dark brownish in the hibernating adults. The species normally breeds in the foothills near arid or desert regions on filaree, atriplex, and other plants and migrates or disperses to the valleys and sugar beet fields in April, May, or June, depending upon the region. The eggs are laid in a wide range of wild and cultivated plants, but sugar beets are preferred during the summer. There are a large number of food plants, chief of which are filaree, atriplex, beets, Russian thistle, sea blite, sarcobotus, creosote bush, mesquite, wild gourd, peppergrass, malva, poverty weed, sea purslane, and lambsquarters. The nymphs and adults in feeding are capable of producing a transparent venation and a curling of the leaves known as curly leaf or curly top. The true nature of the disease is unknown, but it is often responsible for the complete destruction of the crop and causes damage estimated in the millions annually to the sugar beet industry of the Western States. Only individuals having first fed on a diseased plant, which may be filaree, lamsquarters, beets or many other native and cultivated host plants, can transmit the disease to a healthy plant. Other

[1] H. Osborn, Bul. No. 108, Bur. Ent. U. S. Dept. Agr., 1912, p. 72.

[2] C. F. Baker, *Psyche*, 7, suppl. 1896, p. 24. Orig. desc.

E. D. Ball, Bul. 66, pt. 4, Bur. Ent. U. S. Dept. Agr. 1909, p. 33. Bul. 155, Utah Agr. Exp. Sta. 1917.

C. F. Stahl and E. Carsner, *Jour. Agr. Research*, 14, 1918, p. 393.

C. F. Stahl, *Jour. Agr. Research*, 20, 1920, p. 245.

H. H. P. Severin, *Jour. Econ. Ent.*, 12, 1919, p. 312. *Facts about Sugar* 8, nos. 7–13, 1919.

P. B. Lawson, *Kan. Univ. Sci. Bul.*, 12, Ent. 4, 1920.

plants which may harbor the disease and which are also hosts are; the many annual saltbushes, red-stemmed filaree, field, garden and lima beans,

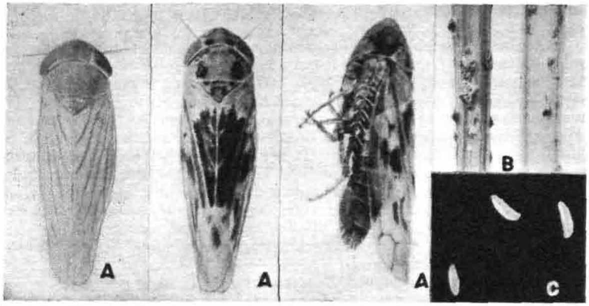

FIG. 110.—The sugar beet leafhopper, *Eutettix tenellus* (Baker). A, different colored adults; B, egg punctures in stems of sugar beet leaves; C, eggs. (After Severin.)

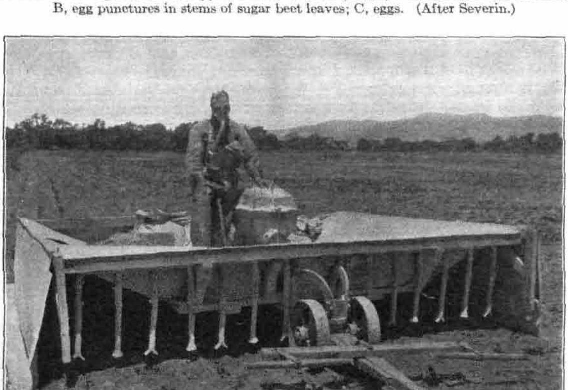

FIG. 111.—Power dusting machine designed for controlling the sugar beet leafhopper, *Eutettix tenellus* (Baker). A canvas apron drops in front. The back is canvas and the sides are thin sheet metal. The operator must wear a gas mask. (After Severin.)

cucumbers, curly dock, datura, malva, mustard, nightshade, oxalis, peppers, pigweeds, radish, shepherd's purse, smartweed, spinach, squashes and many other weeds and cultivated plants. Breeding continues in the

beet fields during the summer, there being but a single brood in the Northern States as in Idaho, and from two to four in California. In some sections there is noticed a definite dispersal or movement of the adult leafhoppers after harvest in the fall towards the natural breeding grounds where the winter is passed.

The species is strictly western and is known in Washington, Idaho, Oregon, California, Nevada, Utah, Colorado, Arizona, and New Mexico. It has been reported also from Argentina, Mexico, and Florida, so its exact native home is questionable.

There are a number of natural enemies which play an important part in reducing the numbers of the pest.

Control measures consist largely of avoiding the areas most likely to be invaded near the breeding grounds. The fog belt areas along the coast and many of the interior districts are sufficiently free from attacks as to be little affected. Applications of nicodusts are efficient but must be often repeated to insure a profitable crop in a heavily infested district (Fig. 111).

E. P. Van Duzee questions the present generic position of this species.

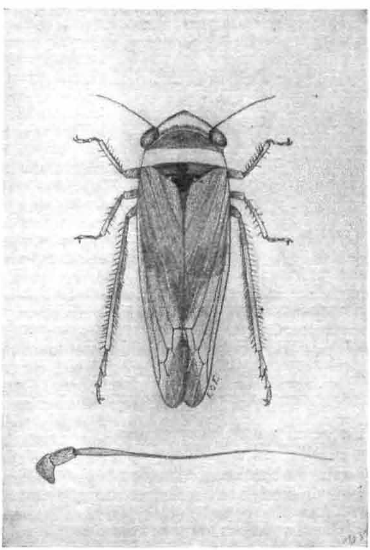

FIG. 112.—The mountain leafhopper, *Thamnotettix montanus* Van Duzee.

The geminate leafhopper, *Thamnotettix geminatus* Van Duzee, is slender, 5 to 6 mm. long, greenish yellow with a pair of black spots on the anterior border of the head, a black spot on each side of the eye, an arched, dusky band near the front border of the pronotum, and black spots on the scutellum. It feeds on grasses, grains, timothy, alfalfa, clover, and apple, and ranges in Alaska, British Columbia, Washington, Oregon, California, and Colorado.

The mountain leafhopper, *Thamnotettix montanus* Van Duzee (Fig. 112), is a small distinctive species 4.5 mm. long, pale or dark brown to dusky with a conspicuous yellow, transverse band on the pronotum, pale face, and a yellow spot on the elytral suture. It is common on grasses, weeds, carrot, larkspur, goldenrod, apple, prune, and other plants, in British Columbia, Washington, Oregon, California, Nevada, Colorado, and probably most of the other Western States.

The black-faced leafhopper, *Thamnotettix nigrifrons* (Forbes) (*Cicadula*), is a small species 3.25 to 4 mm. long, yellowish-green with four large black spots on the mar-

gins of the vertex, whitish or yellowish spots on the pronotum, and with a black transverse line on the yellow scutellum. It is a grass feeder which also attacks timothy, barley, oats, wheat, corn, and other grains. The distribution is largely east of the Rocky Mountains, Colorado and New Mexico being the only Western States included.

The six-spotted leafhopper, *Cicadula sexnotata* (Fallén) (*Cicada*), is a small species 3.5 to 4 mm. long, yellow or yellowish-green with six black spots on the vertex. It infests grasses, grains, and forage crops including barley, oats, millet, rye, wheat, timothy, clover, and alfalfa, and is often a serious pest. It has a wide distribution throughout the country and occur in Alaska and every Western State.

The apple leafhopper, *Empoasca mali* (LeBaron) (*Tettigonia*) [1] (Fig. 113), is a small species 3.5 mm. long, yellowish green with white dashes and lines on the vertex and six or eight white spots on the anterior margin of the pronotum, and a white letter "H" and three white lines on the scutellum. It hibernates in both the egg and adult stages and there are at least two generations annually. The adults are attracted to lights in great numbers. It is a general and destructive feeder on a large variety of plants including weeds and grasses, alfalfa, beans, clover, cowpea, beet, celery, corn, lettuce, dock, potato, apple, and ornamental and native shrubs and bushes. The normal injury is similar to that caused by other leafhoppers, but Ball [2] has shown it to cause a definite type of injury to potatoes, known as hopperburn, and has suggested the common name potato leafhopper because of its feeding and breeding on this plant. The attacks on the potato first produce a wrinkling of the entire surface of the leaf, followed by an upward rolling of the margins and a subsequent burning of the same. The apple leafhopper also transmits fire blight in apple orchards,[3] but is not so intimately associated with fruit trees as it is with leguminous and potato plants. The species is common throughout the Eastern States, but is known in the west only in British Columbia, Washington, Oregon, California, Idaho, and Montana. A fungus, *Entomophthora sphærosperma* Fres., kills many of the nymphs and adults.

Fig. 113.—The apple leafhopper, *Empoasca mali* (LeBaron).

Control measures should be directed against the nymphs. A five per cent nicodust and Bordeaux mixture are recommended for potatoes and similar

[1] R. L. Webster, *The Apple Leafhopper*, Bul. 111, Iowa Agr. Exp. Sta. 1910.
E. P. Van Duzee, "Cat. *Hemiptera*." *Univ. Cal. Pub. Tech. Bul. Ent.*, 2, 1917, p. 705. Complete Biblio.
F. H. Lathrop, *Leafhoppers Injurious to Apple Trees*. Bul. 451, N. Y. Agr. Exp. Sta. 1918.
P. B. Lawson, *Kan. Univ. Sci. Bul.*, 12, *Ent.*, 4, 1920, p. 242. Complete Biblio.
[2] E. D. Ball, *Jour. Econ. Ent.*, 12, 1919, p. 149.
[3] F. H. Lathrop, *Jour. Econ. Ent.*, 12, 1918, p. 147.

plants, while nicotine and soap sprays or five per cent nicodust are the best for nursery stock and fruit trees.

The flavescent leafhopper, *Empoasca flavescens* (Fabr.), is much like the apple leafhopper in form, size, and color, but usually has only three pale spots on the pronotum. It occurs throughout the east, and in Colorado, New Mexico, Arizona, and California in the west. It is attracted to lights and feeds on grasses, beans, peas, alfalfa, cabbage, brussels sprouts, cauliflower, broccoli, beets, carrots, dahlia, nasturtium, turnip, clover, sugar beets, apple, and many other plants attacked by the apple leafhopper.

The unicolor leafhopper, *Empoasca unicolor* Gillette (Fig. 114), is glossy yellowish or green without markings and 3.5 mm. long. It occurs in Colorado on hawthorn and grape. In Oregon it passes its full life cycle on and is destructive to apple and is considered by some to be the real apple leafhopper. It is common in California on various truck crops and on prune trees. It has generally been confused with *Empoasca viridescens* Walsh which it greatly resembles.

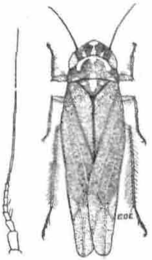

FIG. 114.—The unicolor leafhopper, *Empoasca unicolor* Gillette.

The rose leafhopper, *Empoa rosæ* (Linn.),[1] is 3.5 mm. long and pale yellowish white or whitish with dark eyes and tarsal claws. The nymphs are whitish. The overwintering eggs are laid chiefly in the bark of rose but some may be inserted in the twigs and limbs of apple, prune, and pear, while the first generation of spring eggs are deposited chiefly in the fruit trees. There are two generations a year. The nymphs and adults feed largely on the undersides of the leaves of apple, blackberry, cherry, cottonwood, currant, dogwood, elm, grape, hawthorn, loganberry, maple, oak, pear, plum, prune, raspberry, rose, strawberry, and numerous related rosaceous plants. The egg parasite, *Anagrus armatus* (Ashm.) var. *nigriceps* Girault,[2] destroys many of the eggs in Oregon.

As a control measure Childs recommends the use of lime-sulfur in apple orchards as the ten- and thirty-day scab sprays to kill the nymphs, after which use one part of 40% nicotine sulfate and five pounds of whale oil soap to 100 gallons of water. Rose bushes are also suggested as catch traps to attract the egg-laying females in the fall. Prune and burn to destroy the eggs in the twigs or spray thoroughly when they hatch in the spring to kill the nymphs. A five per cent nicodust has proven effective in killing the young nymphs in California.

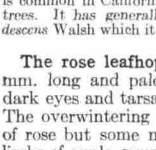

FIG. 115.—The grape leafhopper, *Erythroneura comes* (Say). (After Quayle.)

The grape leafhopper, *Erythroneura comes* (Say)[3] (Figs. 115, 116), is a small slender species from 2.75 to 3 mm. long, pale yellow spotted and marked dorsally with red. The early spring and summer forms are

[1] P. B. Lawson retains the generic name *Typhlocyba* for this species. *Kan. Univ. Sci. Bul.*, 12, Ent. 4, 1920, p. 245.
Leroy Childs, Bul. 148, Ore. Agr. Exp. Sta. 1918.
[2] A. A. Girault, *Ann. Ent. Soc. Am.*, 8, 1915, p. 276.
[3] E. P. Van Duzee recognizes eleven varieties of this species in his "Cata-

pale with yellow predominating, while the hibernating adults are almost entirely red. This species is often a very serious pest to grapes in the warmer grape-growing regions of the country. The adults hibernate on plants, among the leaves, in and about the vineyards, and may be taken on alfalfa, clover, filaree, grasses, mustard, ragweed, and other plants. The eggs are inserted beneath the epidermis on the undersides of the grape leaves and hatch in from fifteen to twenty days. The nymphs feed largely on the under surfaces of the leaves and cause a whitening and eventually a drying-up and shedding of the foliage. The adults of the first brood begin egg-

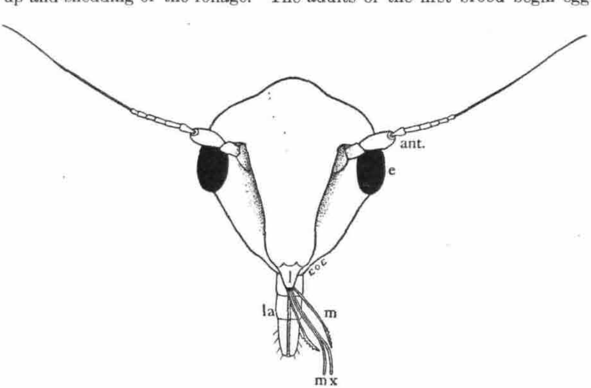

FIG. 116.—Head of the grape leafhopper, *Erythroneura comes* (Say); ant, antenna; e, compound eye; l, labrum; la, labium; m, mandibles; mx, maxillæ.

laying in May, giving rise to the second or summer generation. This brood matures in a few weeks and lays eggs which give rise to the hibernating adults. The summer forms feed chiefly on grape, but also occur on beech, blackberry, burdock, catnip, currant, dewberry, gooseberry, grasses, maple, plum, raspberry, strawberry, Virginia creeper, Boston ivy, and are widely distributed throughout the country being reported in practically every Western State. Control measures consist of the use of soap and nicotine sprays and five-per cent nicodust directed against the nymphs in the same manner as for the rose leafhopper. A ten per cent nicodust kills both the nymphs and adults. Sulfur-nicodust is usually used to control

logue of *Hemiptera*." Also see *Proc. Cal. Acad. Sci.*, 4th series 13, pages 231–236, 1924.

H. J. Quayle, Bul. 198, 1908; Circ. 126, 1915, Cal. Agr. Exp. Sta.

F. Johnson, Bul. 19, U. S. Dept. Agr. 1914.

D. E. Merrill, Bul. 94, N. Mex. Agr. Exp. Sta. 1915.

E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. Cal., Hort. Com. 1915.

W. L. McAtee, "Key to the Nearctic Species and Varieties of *Erythroneura*. *Trans. Am. Ent. Soc.*, 46, pp. 267–322, 1920.

the mildew as well and is more efficient also against the leafhopper. Calcium cyanide dust has also proven very effective in the control of this pest.

The oblique leafhopper, *Erythroneura obliqua* (Say), is 3 mm. long, yellowish with reddish lines and markings. Four varieties are founded upon different color patterns. This species is general throughout the country on grape and is probably as a rule confused with the grape leafhopper. It occurs on plum in Colorado and on grape in California.

FULGORIDÆ.[1] Lanternflies, Fulgorids, Delphacids.

The members of this large, interesting family are a heterogeneous lot but all are characterized by being rather small, having the tarsi 3-jointed, beak plainly arising from the head, the antennæ inserted on the side of the cheek beneath the eyes. There are usually two ocelli, rather long, slender legs, two pairs of wings or wingless. The elytra are long or quite short and the venation variable. The vertex of the head in many species is greatly prolonged like a snout or horn and gives them a queer and often grotesque appearance. The family is of little or no economic importance. Nearly all feed on native plants, many of them being confined to arid regions.

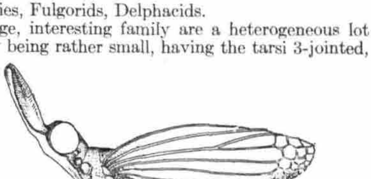

FIG. 117.—The pallid scolops, *Scolops pallidus* Uhler. (After Woodworth.)

The species of *Scolops* are interesting because of the long frontal prolongation. They occur in dry grasses, weeds, and shrubbery. They are common and abundant in the arid southwest but several species like *Scolops sulcipes* (Say) and *S. angustatus* Uhler occur throughout the country. **The pallid scolops,** *S. pallidus* Uhler (Fig. 117), is a yellowish and gray species 6 mm. long, common in Southern California. *S. hesperius* Uhler is various shades of brown and occurs in Colorado, Idaho, Nevada, California, and Texas. *S. abnormis* Ball is 8 mm. long, brown and gray, with large process and is common in California.

The very interesting *Orgerius rhyparus* Stål is nearly circular, flat, wingless, with pointed head, and is 4 mm. long. It assumes an upright position in walking on the long, slender legs and jumps long distances when disturbed. It occurs singly in the dry grass in late summer and fall in Oregon, California, and Mexico. Ball and Hartzell list five varieties.

The cult fulgorid, *Cixius cultus* Ball, is a black and brown species 5 to 6 mm. long with grayish wings. It often swarms in great numbers in low native growths. The

[1] W. L. Distant, *Biol. Centr. Am. Homoptera*, 1, 1883, p. 21.

E. P. Van Duzee, "Synopses." *Proc. Acad. Nat. Sci. Philad.*, 59, 1907, p. 467. "Cat. *Hemiptera*." *Univ. Cal. Pub. Tech. Bul. Ent.*, 2, 1917, p. 716.

Z. P. Metcalf, "Wing Venation of *Fulgoridæ*." *Ann. Ent. Soc. Am.*, 6, 1913, p. 341.

D. L. Crawford, "Mon. *Delphacidæ* of No. & So. Am." *Proc. U. S. Nat. Mus.*, 46, 1914, p. 557.

E. D. Ball and A. Hartzell, "Rev. Desert Leafhoppers of the *Orgerini*." *Ann. Ent. Soc. Am.*, 15, 1922, p. 137.

writer has taken great numbers on lippia in the Sacramento Valley, California, but it is also abundant elsewhere in the central part of the State and is reported from Colorado and Kansas.

The date fulgorid, *Asarcopus palmarum* Horvath, is 4–6 mm. long, reddish-brown in the nymphal stage and very dark brown in the adult stage. The adults are apterous or have only rudimentary wings, but hop freely. This species attacks the crown leaves and bases of the fruit stems of the date palm and exudes quantities of honeydew over the plants. It is a native of Egypt and the old world date growing regions and was first noted in the date orchards of Southern California in 1924 by F. Stickney.

CHERMIDÆ.[1] Jumping Plant Lice or Psyllids.

The members of this small family are easily separated from the other families of this order. The adults appear like miniature cicadas but are about the size of aphis or plant lice. They have the ability to jump and are therefore known as jumping plant lice. Like the aphis the rostrum arises far back on the venter of the head, but the wing venation readily separates the two families. The eggs are elongate and usually attached by a short stipe. The nymphs are very characteristic, being oval or slightly elongated, flat with conspicuously large wing pads, and often with a marginal fringe around the body. In some species the eggs, nymphs, and adults are covered with thin or with very long white, cottony wax, completely hiding them. Like their near relatives they are plant feeders, and often cause pseudogalls on the leaves and plants. The excrement of some species is in the form of small pellets of white crystal-like honeydew. The large majority of the psyllids feed on native plants and but few may be considered injurious to cultivated and ornamental plants. Some of these latter have been imported on ornamentals from foreign countries. Control measures consist of applications of nicotine and soap or miscible oil sprays and nicodust as suggested for aphis. The dusts are never effective against nymphs or adults protected with a thin or thick waxy covering.

Only the most interesting western forms are discussed.

The carex psyllid, *Livia caricis* Crawford, is 2.5 mm. long, almost black or from orange to pale brown. It occurs on carex in Colorado and is common throughout the country, also being known in the west in Utah, New Mexico, California, Oregon, and British Columbia.

The knotweed psyllid, *Aphalara calthæ* (Linn.) (*Chermes*), varies from 1.6 to 2.2 mm. in length, and is light reddish brown or dark chocolate brown in color, the wings furnate or with brown bands. The nymphs are often covered with white, cottony wax. The hosts are alfalfa, tomato, knotweed, gooseberry, artemisia, caltha, pine, dock, carex, and weeds. It is reported on larch and spruce in England. The distribution covers most of North America, Europe, and Japan. In the west it is known in Washington, Oregon, California, Nevada, Wyoming, Utah, Colorado, Arizona, and New Mexico. It hibernates in the adult stage in coniferous trees where available.

The dock psyllid, *Aphalara rumicis* Mally, is similar to *A. calthæ* (Linn.), with the wings more colored. It occurs on dock, *Sophia*, and weeds in Oregon, California, Wyoming, and Colorado (U. S.).

[1] The name of this family has previously been known as *Psyllidæ*. See E. P. Van Duzee, "Cat. Hemiptera," *Univ. Cal. Pub. Tech. Bul. Ent.*, 2, 1917, p. 782. Biblio.

D. L. Crawford, "American *Psyllidæ*." *P. C. Jour. Ent.*, 2, 1910, pp. 228, 347; 3, 1911, pp. 422, 480, 628. *Mon. Psyllidæ of New World.* Bul. 85, U. S. Nat. Mus. 1914.

E. A. Schwarz, "*Psyllidæ* of Alaska." *Herriman Alaska Exped. Proc. Wash. Acad. Sci.*, 2, 1900, p. 539. "Notes on Am. *Psyllidæ*." *Proc. Ent. Soc. Wash.*, 6, 1904, p. 234.

E. M. Patch, "Homol. Wing Veins of *Aphididæ*, *Psyllidæ*, *Aleyrodidæ* and *Coccidæ*." *Ann. Ent. Soc. Am.*, 2, 1909, p. 101. *Psyllidæ of Maine.* Bul. 187, Maine Agr. Exp. Sta., 1911. "Notes on *Psyllidæ*." *Psyche*, 15, 1912, p. 19. Bul. 202, Maine Agr. Exp. Sta., 1912, p. 215.

The artemisia psyllid, *Aphalara artemisiæ* Förster, is whitish or flavous, 1.3 to 1.5 mm. long, with spotted wings, occurring on *Artemisia* in Colorado and Utah. *A. angustipennis* Crawford is much like the former, but slightly larger, 2.3 to 3.5 mm. long and infests *Artemisia* in Washington, Oregon, California, Utah, and Colorado (U. S.).

The Alaska psyllid, *Aphalara alaskensis* Ashmead, is 2.1 mm. long, dark brown to black, ranging from Alaska south into British Columbia, Washington, and Colorado.

The sumach psyllid, *Calophya californica* Schwarz, is 1.6 mm. long, black to brown, infesting California sumach in Southern California. *C. triozomima* Schwarz is 1.7 mm., reddish or black with yellowish abdomen, and occurs on *Rhus trilobata* in Arizona, Colorado, and California.

The alfalfa psyllid, *Kuwayama medicaginis* (Crawford) (*Paratrioza*), is 1.7 mm. long and pale green. It infests alfalfa in Colorado and California.

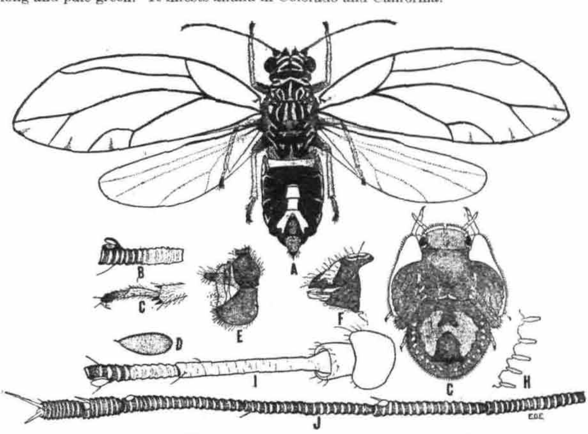

FIG. 118.—The tomato psyllid, *Paratrioza cockerelli* (Sulc). A, adult female; B, fourth joint of antenna showing sensorium with covering or operculum; C, tip of tibia and the tarsus; D, egg; E, genitalia of male; F, genitalia of female; G, nymph; H, marginal fringe of nymph; I and J, antenna showing the ten joints.

The lavatera psyllid, *Kuwayama lavateræ* Van Duzee, is a pale green and black species, the green nymphs of which live in small blister like areas produced often in great numbers on the leaves of lavatera in the San Francisco Bay Region, California. The writer took this species in abundance on the same host at Ventura, California, in 1918 and at Santa Cruz, Cal., in 1924.

The tomato psyllid, *Paratrioza cockerelli* (Sulc) (*Trioza*)[1] (Fig. 118), is 1.4 mm. long, light to dark brown, head and thorax black with white lines and spots. The nymphs are pale yellowish and orange; the eggs, pale yellow and attached by a very short stipe. There are three broods a year. The adults hibernate in pine trees wherever possible. The hosts are alfalfa,

[1] H. Compere, *Mthly. Bul.*, Cal. Hort. Com. 1916, p. 189.
E. O. Essig, *Jour. Econ. Ent.*, 10, 1917, p. 434.

arborvitæ, *Solanum* spp., spruce, tobacco, *Datura*, *Iochroma*, nightshade, pepper, petunia, pine, tomato, and potato. It is known in Colorado, Utah, New Mexico, Arizona, and California, and is often present in sufficient numbers to warrant spraying the infested plants with nicotine and soap, or dusting with nicodust, as recommended for thrips and aphis.

The spotted-winged psyllid, *Paratrioza maculipennis* (Crawford) (*Trioza*), is 1.7 mm. long, dark brown to black, with brown spots on the apical portions of the wings. It occurs on wild morning glory, ceanothus, and willow in California.

The laurel psyllid, *Trioza alacris* Flor [1] (Fig. 119), is 1.9 mm. long, greenish yellow to pale brown with pale and dark maculations. The eggs are whitish or pale yellow, darker or orange at the tip, covered with fine, white, powdery

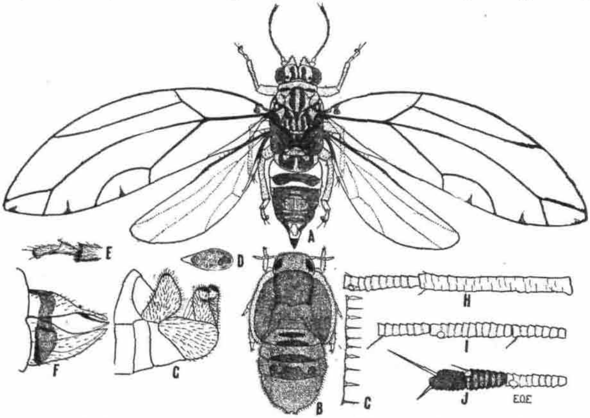

FIG. 119.—The laurel psyllid, *Trioza alacris* Flor. A, adult female; B, nymph with the cottony covering removed; C, spines covering body of the nymph; D, egg; E, tip of tibia and the tarsus; F, genitalia of female; G, genitalia of male; H, I, and J, antennal joints 3–10.

wax. The nymphs are pale yellow and orange, entirely hidden by long, white, cottony wax. This species was imported from Europe and occurs in Central and Southern California and also in New Jersey. It is a pest of the laurel or sweet bay, producing a curling, thickening, and reddening of the edges of the leaves, giving the plants a very unsightly appearance and reducing their vitality by causing the leaves to drop. The Canary laurel and laurel cherry are also host plants. The adults hibernate on or about the hosts. Control consists in the application of miscible or distillate oil sprays directed against the nymphs in spring and summer.

[1] D. L. Crawford, *Mthly. Bul.*, Cal. Hort. Com. 1, 1912, p. 86. Bul. 85, U. S. Nat. Mus. 1914, p. 94.
E. O. Essig, *Jour. Econ. Ent.*, 10, 1917, p. 439.

The white-fronted psyllid, *Trioza albifrons* Crawford, is 1.9 mm. long, orange to brown with whitish markings and stripes on the head, basal third of antennæ, and pronotum. It infests potatoes, tomatoes, and nettles in Southern California and also occurs in Montana.

The common willow psyllid, *Trioza maura* Förster, varies from 1.8 to 2.3 mm. long and from light orange to reddish brown or dark red in color. It infests a large variety of willows throughout America and Europe, and occurs in Washington, Oregon, California, Nevada, Utah, Colorado, and New Mexico.

The black willow psyllid, *Trioza nigrilla* Crawford (*T. salicis* Mally, *T. nigra* Crawf., *T. minuta* Crawf. var. *similis* Crawf.), is similar to *T. maura* Förster, but darker. It is common in willows in Washington, California, Nevada, and Colorado (U. S.).

The California willow psyllid, *Ceropsylla californica* Crawford, is 2 mm. long, orange to dark brown, head almost black. It occurs on willow in California and Colorado.

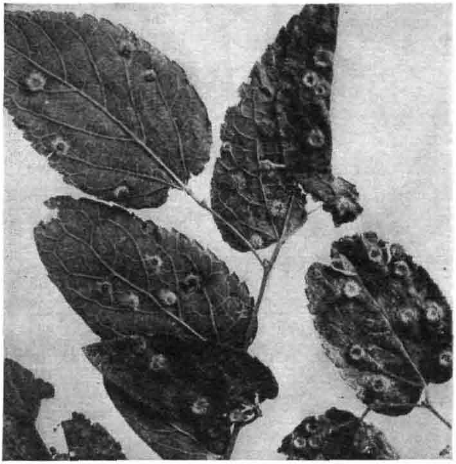

FIG. 120.—Galls of the hackberry gall psyllid, *Pachypsylla celtidis-mamma* Riley, on leaves of hackberry.

The hackberry gall psyllid, *Pachypsylla celtidis-mamma* Riley[1] (Fig. 120), is pale to dark reddish brown, moderately robust, and 2.4 mm. long. It forms curious little globular, hairy galls on the undersides and crater-like depressions on the upper sides of the leaves of hackberry in the Eastern States. It ranges through Colorado and Utah.

The manzanita psyllid, *Euphyllura arctostaphyli* Schwarz, is 2.4 to 3 mm. long; head and thorax reddish, cinnamon brown, or yellowish; abdomen blood red; wings with brown maculations; legs reddish. It infests manzanita in Washington, California, Wyoming, Colorado, and Arizona. The variety *niveipennis* Schwarz has white wings with brown spots on the apical margins and occurs in California.

The madrona psyllid, *Euphyllura arbuti* Schwarz (Fig. 121), is 2.6 mm. long and reddish in color to match the bark of the madrona trees on which it feeds. The nymphs

[1] The Utah specimens were collected by W. W. Jones and determined by E. P. Van Duzee.

are enclosed in a globular, white, felt-like sac, and are often mistaken for a scale insect. They secrete quantities of honeydew and are often responsible for smutting the trees, besides seriously injuring them in feeding. This pysllid is abundant and destructive to madrona trees along the coast of California and particularly in the San Francisco Bay Region and the Santa Cruz Mountains. Spraying the trees with miscible oil in the late fall or early spring to kill the nymphs is only practical in gardens. In the woods the insect is serious only spasmodically.

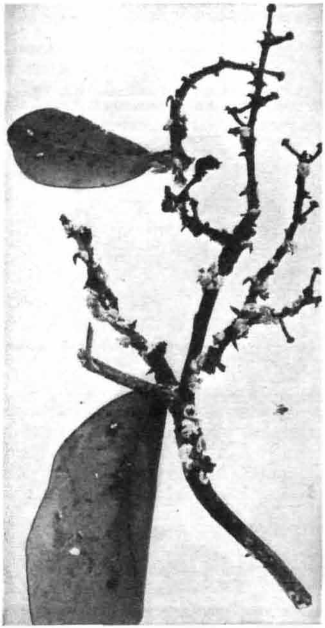

FIG. 121.—The madrona psyllid, *Euphyllura arbuti* Schwarz. Characteristic infestation on madrona showing the white felt-like coverings of the nymphs on the twigs and a single adult at the right.

The Arizona madrona psyllid, *Euphyllura arbuticola* Crawford, very much resembles the California species. It occurs on *Arbutus arizonica* in Arizona.

The ceanothus psyllid, *Arytaina ceanothæ* Crawford, is 1.7 mm. long, yellowish, light brown to dark brown in color. Common on *Ceanothus* and *Rhamnus* in California.

The currant psyllid, *Arytaina ribesiæ* (Crawford) (*Psyllopa*), is 2.2 mm. long, and pale to dark brown in color. It occurs on wild and cultivated currants, ceanothus, and other low bushes in California, Arizona, Utah, and Colorado.

The American psyllid, *Psyllia*[1] *americana* Crawford, is from 2 to 2.5 mm. long, reddish to pale or very dark brown in color, and occurs abundantly on yellow and one-leaf piñon pines in California. The variety *minor* Crawford, is much like the above in size and color, but occurs only on various species of willow in California and Colorado.

The boxwood psyllid, *Psyllia buxi* (Linn.), is a bright green species, 3 mm. long. The nymphs are often covered with long, thin, white, cottony wax. This species seriously injures the ornamental boxwood by attacking the new growth and causing a curling of the leaves. It is a European species introduced into the United States. The writer has taken it in quantities at San Jose, California.

The cottony alder psyllid, *Psyllia floccosa* Patch, is from 2 to 4 mm. long, and pale yellowish-green or often brownish in color. The nymphs are yellow and green and are entirely covered with a long, dense mass of white, fluffy wax. They are often abundant in great numbers on the young leaves of alder in early spring. It is a common species in some of the Eastern States, and in California and Colorado in the west. **The American alder psyllid,** *P. alni americana* Crawford, is much the same in appearance except that the nymphs are brownish with dark cross bands at the base of the abdomen. They are, however, covered with the long, white, cottony wax, and occur on the leaves of alder in California and Nevada.

[1] The writer is using the old form *Psyllia* as given in Van Duzee's *Catalogue*, rather than the more recent *Psylla*.

The pear psylla, *Psyllia pyricola* Förster,[1] is 1.5 mm. long and pale orange to reddish brown with darker markings. The hibernating forms are larger and very dark reddish brown to black. The nymphs are yellowish to pale brown with wing pads and body markings dark brown or blackish. The eggs are pale yellow, elongate oval, and attached singly or in rows in cracks of the bark on the trunks and limbs, or around the terminal buds of the last year's growth. They are laid in April and hatch in from ten to thirty days. There are about four broods annually. This species is a serious pest of pear trees east of the Rocky Mountains and has been reported from a number of Western States at different times. It has been reported in British Columbia and California, but the writer is sure that in California the pear psylla has never been found previous to this writing.

APHIDOIDEA (Superfamily) [2]

Aphis, Plant Lice

The aphis or plant lice comprise a large superfamily of small, delicate insects well known to all who are interested in plant life because of their

[1] C. L. Marlatt, Circ. 7, Bur. Ent. U. S. Dept. Agr. 1895.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. Cal., Hort. Com. 1915, p. 67.

[2] The writer is indebted to A. C. Baker and P. W. Mason for corrections in nomenclature and synonymy.
Cyrus Thomas, "*Aphididæ* of Illinois." *Eighth Rept. Ent.* Ill. 1879.
O. W. Oestlund, "*Aphididæ* of Minnesota." *14th Ann. Rept. Geol. & Nat. Hist.* Surv. Minn. 1886, p. 17. Bul. 4, Geol. & Nat. Hist. Surv. Minn. 1887.
W. D. Hunter, *Aphididæ N. A.* Bul. 60, Iowa Agr. Exp. Sta. 1901.
W. T. Clarke, "List of Calif. *Aphididae*." *Can. Ent.*, 35, 1903, p. 247.
C. E. Sanborn, "Kansas *Aphididæ* and Cat. N. A. *Aphididæ*." *Kan. Univ. Sci. Bul.*, 3, 1904, pp. 3, 211.
C. P. Gillette, "*Chermes* of Colorado Conifers." *Proc. Acad. Nat. Sci. Philad.*, 1907, p. 3. *Can. Ent.*, 39, 1907, p. 389. *Jour. Econ. Ent.*, 1, 1908, pp. 302, 359; 2, 1909, pp. 351, 385; 3, 1910, pp. 367, 403. *Ent. News*, 22, 1911, p. 440; 29, 1918, p. 281. *Ann. Ent. Soc. Am.*, 4, 1913, p. 485; 10, 1917, p. 133.
C. P. Gillette and E. P. Taylor, *A Few Orchard Plant Lice*. Buls. 133 and 134, Colo. Agr. Exp. Sta. 1908.
C. P. Gillette and L. C. Bragg, "Colorado *Aphididæ*." *Ent. News*, 27, 1916, p. 445. *Jour. Econ. Ent.*, 8, 1915, p. 97; 10, 1917, p. 337; 11, 1918, p. 328.
E. M. Patch, *Eastern Aphididæ*, Many bulletins of Main Agr. Exp. Sta. 147, 1907 to 282, 1919. "Homologies of Wing Veins of *Aphididæ*," etc., *Ann. Ent. Soc. Am.*, 2, 1909, p. 101. *Jour. Econ. Ent.*, 10, 1917, p. 416.
W. M. Davidson, California *Aphididæ*." *Jour. Econ. Ent.*, 2, 1909, p. 299; 3, 1910, p. 372; 7, 1914, p. 127; 8, 1915, p. 419. "Walnut Aphides of Calif." Bul. 100, *Prof. Paper*, U. S. Dept. Agr. 1914.
E. O. Essig, "California *Aphididæ*." *P. C. Jour. Ent.*, 1, 1909, pp. 1, 47, 98; 2, 1910, pp. 223, 283, 335; 3, 1911, pp. 400, 457, 523, 586; 4, 1912, pp. 698, 758, 826; 7, 1915, p. 180; 14, 1922, p. 61. *Univ. Calif. Pub. Tech. Bul. Ent.*, 1, No. 7, 1917, p. 301.
D. T. Fullaway, "Syn. Hawaiian *Aphidæ*." *Ann. Rept. Hawaiian Agr. Exp. Sta.*, 1909, p. 20.
H. F. Wilson, *Ann. Ent. Soc. Am.*, 3, 1910, p. 314; 8, 1915, p. 347. "Oregon *Aphididæ*." *Trans. Am. Ent. Soc.*, 41, 1915, p. 85. "Aphid Notes from B. C." *Proc. Ent. Soc. B. C.* 1915, p. 1. *Can. Ent.*, 42, 1910, p. 381; 51, 1919, pp. 18, 41. *Ent. News*, 29, 1918, p. 230; 30, 1919, p. 39.
H. F. Wilson and R. A. Vickery, "Species List of *Aphididæ* of World and Food Plants. *Trans. Wisc. Acad. Sci., Arts, Letters*, 19, pt. 1, 1918.
T. A. Williams, "*Aphididæ* of Nebraska." *Contrib. Dept. Ent. Univ. Nebr.* 1910.
A. C. Baker, "Syn. Genus *Calaphis*." *Proc. Ent. Soc. Wash*, 18, 1916, p. 184. "East-

abundance on, and injury to all types of vegetation. The antennæ are well developed, the rostrum arises well back on the underside of the head, and there are usually 3 ocelli in the alate forms. The adults are apterous or have two pairs of thin, membranous wings with a few simple veins; the tarsi are 2-jointed and terminate in two claws. The life histories are interesting and often complicated, and will be more carefully noted under the various species. The winter is passed in either the adult, nymph, or egg stage, usually on some host plant. In the spring the eggs hatch into stem-mothers which are apterous and parthenogenetic. They become mature in three or four weeks and give birth usually to apterous females. There may follow one or two broods of apterous forms after which winged migrants appear and may in many cases entirely replace the wingless forms. Bringing forth young continues unbroken throughout the summer and until late fall or winter, when sexual males and females appear. After mating the female deposits one or more overwintering eggs. The eggs are small, oval, at first yellowish or greenish, but soon turn to a shining black. Hibernating nymphs and adults are parthenogenetic females which continue to reproduce their kind year after year. In the warmer sections of the west most of the common species omit the egg stage entirely. Reproduction is rapid and enormous numbers result from a single female annually.

Aphis are injurious to all forms of plant life and may be found on the bark, leaves, blossoms, fruit, and roots. Some produce large, warty excrescences on the bark, while others produce curling or pseudogalls and true galls on the foliage. Feeding consists in extracting the juices from the plant tissues and results in the abnormalities already referred to, and in a drying up and weakening of the whole plant. Many are also responsible for disseminating fungus and other plant diseases. Most species excrete quantities of honeydew over the host plants, which is greedily sought by flies, ants and bees, and which also is the medium for the growth of the black smut fungus.

The large majority of species are naked, but a great many scerete, as a protection, varying amounts of white, powdery, or long, thick, cottony waxlike material.

Natural enemies, consisting of predators and parasites, extensively prey upon these helpless creatures. Chief among the predators are the larvæ of the green lacewings of the *Neuroptera*, the ladybird beetles of the *Coleoptera*, and syrphid flies of the *Diptera*, while the most important parasites are braconids and figitids of the *Hymenoptera*. The different members of all of the above are listed under the various hosts.

The fungus, *Enomophthora aphidis* (Hoffm.), attacks many species in the west.

ern *Aphididæ*." *Jour. Econ. Ent.*, 10, 1917, p. 420. "Generic Classif. *Aphididæ*." Bul. 826, *Prof. Paper*, U. S. Dept. Agr. 1920.

A. L. Quaintance and A. C. Baker, "Aphids Inj. to Orchards, Fruits," etc. *Farmers' Bul.* 804, U. S. Dept. Agr. 1917.

A. F. Swain, "New *Aphididæ* of California." *Trans. Am. Ent. Soc.*, 44, 1918, p. 1. *Ent. News*, 29, 1918, p. 361. "A Syn. of *Aphididæ* of Calif." *Univ. Cal. Pub. Tech. Bul. Ent.*, 3, No. 1, 1919, p. 1.

C. D. Duncan, "N. A. Species of *Phylloxera* Infesting Oak and Chestnut." *Can. Ent.*, 54, 1922, p. 267.

Control measures are very effective against aphis. They may be summarized as follows:

For eggs—Apply as dormant sprays just as the buds begin to swell:

1. Crude Oil Emulsion, 1 part to 9 parts of water.
2. Commercial Lime-Sulfur Solution, 1 gallon to 9 gallons of water to which is added 2 pints of 40 per cent nicotine sulfate to every 200 gallons of the above.

For aerial forms—Apply as soon as insects appear and before leaves begin to curl:

1.	Fish Oil Soap (or Calcium Caseinate ½ pound)	5 pounds
	Nicotine Sulfate, 40 per cent	1 pint
	Water to make	100 gallons
2.	Fish Oil Soap	7 pounds
	Miscible Oil	1 gallon
	Water to make	100 gallons

3. Miscible oil, 10 gallons to 100 gallons of water is recommended as a dormant spray for the woolly aphis.
4. Nicodust, 2 per cent to 5 per cent of pure nicotine, applied dry. This material *is very effective on some plant lice, but is not satisfactory for all species.*
5. Calcium cyanide, 10 per cent to 25 per cent is effective, but the latter strength may cause some burning of the foliage and should never be used when the leaves are wet.

For root forms—Apply in late summer or fall:

1. Paradichlorobenzene, 1 ounce to a tree, is effective on woolly apple aphis and pear root aphis in California.
2. The spraying solutions as recommended for the aërial forms. Apply 3 or 4 gallons per tree.
3. Carbon disulfid, 1 ounce to 4 gallons of water thoroughly mixed and applied in a basin to each infested tree.

KEY TO FAMILIES [1]

Summer parthenogenetic oviparous forms produced; stigma of the fore wings bounded behind by the radial sector .... **Phylloxeridæ**

Only sexual oviparous forms produced, usually in the fall; stigma of the fore wings bounded behind by the radius .... **Aphididæ** p. 229

PHYLLOXERIDÆ. Phylloxera, Chermes.

The grape phylloxera, *Phylloxera vitifoliæ* Fitch (*P. vastatrix* Planchon)[2] (Fig. 122), is the most notorious member of the family and perhaps the best known of all the aphis because of its destructiveness to the roots of grapevines in California, the Eastern States, and in Europe. According to Davidson and Nougaret [3] the biology of the insect in California, where the life cycle differs from that in the Eastern States, is briefly as follows: all are oviparous, parthenogenetic females, the adult late autumn forms of which are oval or pyriform in shape, yellowish green or yellowish brown in color, 1 mm. x 0.55 mm. in size, occur on the roots, and are known as radicicole. The eggs are oval and lemon-yellow in color and 0.26 mm. in length. The late autumn eggs hatch into radicicole which hibernate on the roots in a dormant

[1] After A. C. Baker with modifications.

[2] The well known genus *Phylloxera* is used in preference to the less known *Peritymbia* of European writers.

[3] W. M. Davidson and R. L. Nougaret, "Grape *Phylloxera* in California." Bul. 903. *Prof. Paper*, Bur. Ent. U. S. Dept. Agr. 1921.

condition from the middle of October to the middle of April. Activity then begins, and after four molts the hibernants reach maturity and give rise to as many as eight generations during the summer period from April 15th to October 15th. Most of the young radicicole appearing from the last of June to the first of November leave the roots of the infested vines by following up the trunk or through soil cracks, and seek new vines and are very appropriately called wanderers or wandering radicicole. These establish new colonies and spread the infestation. Although the wanderers may be carried by birds, other insects, wind, and irrigation, the very

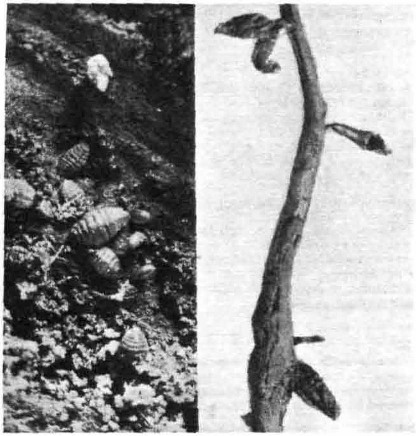

FIG. 122.—The grape phylloxera, *Phylloxera vitifoliæ* Fitch. Colony consisting of the adult female, eggs and young on a large grape root at left and typical galls on small grape rootlets at the right.

slow spread of the pest clearly indicates that the chief means of distribution in a vineyard is by the crawling wanderers from vine to vine. Elongated, orange yellow, winged sexuparous migrants also appear chiefly in the coast region from the middle of June to the first of November. These forms lay male and female eggs which hatch into sexual forms and in the Eastern States mate, the females laying the overwintering eggs, but in California the sex forms do not seem to mature. The gall or gallicole form is also omitted in California although a leaf-inhabiting form is recorded from Arizona. The active destructive period is from the middle of April to the middle of October when the vines show clearly the attacks of the radicicole. The hibernants live on the main roots during the dormant season while the active radicicole attack the small feeding roots producing little oval galls and eventually destroying entirely all of the feeding roots, which

results in the slow death of the vines. The phylloxera is a native of the middle and Eastern States inhabiting the roots of the American grape without seriously injuring them. It was probably carried on rooted vines to Europe and to the Western States where the European grape is cultivated. Its attacks on this variety proved so destructive as to threaten the grape-growing industries of these regions. It reached California in 1852, about as soon as it became known in France, and spread rapidly throughout the northern half of the State, but has never gained a foothold in the extensive vineyards of the southern half. The pest is known in Arizona where it occurs on wild grapes but is largely confined to the leaves, and is not yet a pest of commercial plantings according to A. W. Morrill.[1] It is also reported from New Mexico.[2] Control measures consist largely in quarantine regulations preventing the distribution of infested rooted vines or other carriers from infested areas; and in the use of the so-called resistant roots of certain American varieties which are least susceptible to injury by phylloxera as rootstocks for the European varieties.[3] Although thoroughly proved as a means of preventing serious phylloxera attacks for many years, very few of the vines of the many California vineyards are actually on resistant stocks, due chiefly to the cost of propagation and to the fact that most of the new vineyards are planted on land never before used for grapes and therefore free from the pest. The spread of the insect and the continued growing of vines on the same piece of land for many years, will in time make resistant stocks absolutely necessary for the proper continuance of the grape and raisin industry of California.

The poplar phylloxera, *Phylloxera popularia* Pergande, is a pale yellow, cottony-covered species common in the cracks on the twigs and limbs of cottonwood and poplar trees in California. *P. salicola* Pergande is also a pale yellow, cottony-covered species infesting the roots of willow and the twigs of willow and cottonwood in California, and poplar in Utah. *P. stanfordiana* Ferris is a yellow, naked species inhabiting the bark of blue oak at Palo Alto, California.

The members of the genus *Chermes* are not well understood throughout our territory. Professor C. P. Gillette [4] has published a very valuable work on Colorado species, from which most of our information is gleaned.

Cooley's chermes, *Chermes cooleyi* Gillette (*C. coweni* Gill.),[5] may be taken as an example of the life history as it occurs in the Rocky Mountain region. The presence of this louse is plainly indicated in the spring of the year by the many small tufts of white, cottony material which cover the small bodies of the individual females resting on the needles of the food plants. The hibernating females or stem-mothers are exceedingly small, very dark green or black with a fringe of white, waxy threads around the margin and

[1] *Fifth Ann. Rept.* Ariz. Com. Agr. & Hort. 1913, p. 34.

[2] T. D. A. Cockerell, Bul. 35, N. M. Agr. Exp. Sta. 1900.

[3] F. T. Bioletti, F. C. H. Flossfeder and A. E. Way, *Phylloxera-Resistant Stocks.* Bul. 331, Cal. Agr. Exp. Sta. 1921.

[4] "*Chermes* of Colorado Conifers." *Proc. Acad. Nat. Sci. Philad.*, 1907, p. 3.

[5] The species commonly taken in California and along the Pacific Coast have generally been referred to this species and to *C. pinicorticis* Fitch (Fig. 123). Mr. P. A. Annand who is working on the group advises the writer that the common form in this region is *C. coloradensis* Gillette which inhabits the needles of bull, lodgepole and piñon pines in Colorado. The former is reported by Gillette in Colorado.

a row down the middle of the dorsum. The antennæ are three-jointed. In the spring (April) the entire body is covered with the white cottony material. At this time the color changes to a reddish-brown. Fully mature specimens vary from 0.08 to 1 mm. in length and are three-fourths as wide. The eggs are oval and light yellow. The pupæ are first rusty-brown, becoming darker with age. The dorsum is covered with white powder and dark, glandular spots. On the abdomen there are six longitudinal rows of these glands in which the cottony covering is secreted. The winged females are also reddish brown with black head and thorax and dusky five-jointed antennæ and legs. The bodies are covered with rather dense, white, cottony threads, allowing only the wings to show. They are about the same size as the full-grown apterous females. The winter is spent by the small females or stem-mothers on the surface of the needles of the red fir or the Douglas fir. In the spring these females begin to grow and cover the bodies with white, cottony wax and to secrete quantities of honeydew. About the middle of April or earlier they begin to lay eggs, each depositing from twenty-five to forty. These hatch in about two weeks and the young settle and feed on the new and tender tips of the twigs. They mature into winged and apterous females. The apterous forms deposit eggs which hatch into hibernating females, while the winged forms migrate to the silver spruce and lay eggs which hatch very quickly. The young of these settle on the tender needles at the tips and cause large, light green or purplish galls which may be from $1^3/_4$ to 2 inches long. About the middle of July those on the silver spruce become full grown, winged migrants, and fly to the red fir or the Douglas fir and lay eggs which hatch also into hibernating females. Professor Gillette states that "It is certain that the forms on the Douglas fir are the descendants of the migrants from the silver spruce, and it is equally certain that the gall-producing forms on the silver spruce are the immediate descendants of the winged migrants from the Douglas fir." The life history has not been worked out for the Pacific coastal region where there are likely to be some minor differences. Though the infested trees are seldom killed[1] by the attacks of the lice, they often appear stunted and very unsightly because of the black smut fungus which covers the honeydew over the entire leaf surface of the trees. Char-

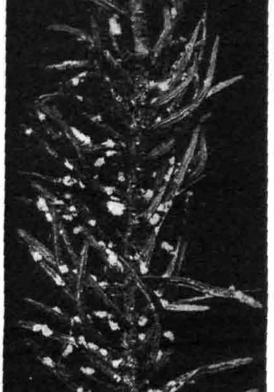

FIG. 123.—Colony of *Chermes pinicorticis* Fitch on Douglas fir. The bodies are covered with a white cottony wax.

[1] R. N. Crystal reports many Sitka spruce trees killed by it in British Columbia.

acteristic cone-like terminal galls are also formed on the twigs. The distribution of the different species throughout the west is not known. This species is recorded from Colorado, British Columbia, Washington, Oregon, and California, but this may also involve *C. coloradensis* Gill. The food plants are chiefly spruce and fir, including Colorado blue, Engelmann, Sitka, and silver spruce, and red and Douglas firs. The chief natural enemies are ladybird beetles and larvæ of syrphid flies. W. M. Davidson reports also the predaceous beetle, *Podabrus tomentosus* Say,[1] attacking it in California. Control is successful with applications of miscible oil or crude carbolic acid emulsions during the winter, as recommended for scale insects. *Chermes montanus* Gillette produces cone-shaped galls at the tips of the twigs of Colorado blue spruce in Colorado at high elevations. *C. pinicorticis* Fitch is apparently the common species on spruce, pine, and fir along the Pacific Coast from British Columbia to California and in Colorado, and is responsible for serious damage. *C. similis* Gillette is common and serious to spruce in British Columbia[2] and produces a gall similar to that of *C. cooleyi* Gill. It also occurs in Colorado. Eric Walther has secured excellent control by spraying the infested trees with 5 gallons of miscible oil, 1 quart of 40% nicotine sulfate, and 200 gallons of water in the spring of the year when the young colonize on the new growth.

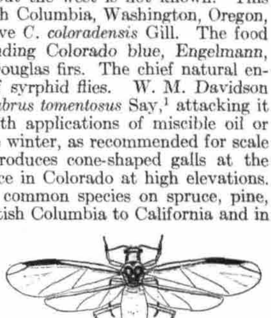

FIG. 124.—The Monterey pine aphis, *Essigella californica* (Essig). Winged female, nymph, and apterous female.

APHIDIDÆ.[3] Aphis, Plant Lice.

The Monterey pine aphis, *Essigella californica* (Essig) (*Lachnus*) (Fig. 124), is a slender, green species 1.5 mm. long, with very long hind legs. It infests the needles of the Monterey pine in California. H. F. Wilson reports it on yellow pine and Douglas fir in Oregon, and Edith M. Patch has taken it from white pine in Maine.

Members of the large genus *Dilachnus* (*Lachnus, Wilsonia*) are large, mostly brown species with hairy bodies often covered with whitish, powdery wax, short, cone-like cornicles, 6-segmented antennæ, and long hind legs. They are chiefly bark feeders occurring in dense colonies on the limbs and smaller twigs of coniferous trees. Apterous forms are much more abundant than winged individuals. They produce quantities of honeydew and cause black-smutting of the infested trees. *D. arizonica* (Wilson) infests pine in Arizona. *D. braggi* (Gillette) is dark yellowish brown, almost entirely covered with white pulverulence and occurs on Colorado blue spruce in Colorado. *D. burrilli* (Wilson) is black with white pruinose mottlings and infests Rocky Mountain red juniper in Idaho and Colorado. *D. caudelli* (Wilson) occurs on spruce in British

[1] *Jour. Econ. Ent.*, 3, 1910, p. 372.

[2] W. H. Brittain, *Proc. B. C. Ent. Soc.*, 1912, p. 15.

[3] I have used the common name aphis in preference to either aphid or plant louse for the reason that this name certainly antidates the scientific generic name, and I believe it is very important now to attempt to standardize the common names in view of the constant changes in scientific names.

Columbia; *D. edulis* (Wilson), on *Pinus edulis* in Colorado. *D. ferrisi* (Swain) occurs in large colonies on limbs of white fir in California, *D. glehnus* (Essig) a pulverulent species, on the apical twigs of Japanese dwarf silver spruce, in California. *D. montana* (Wilson) occurs on *Pinus laricis* in Montana. *D. occidentalis* (Davidson) is a dark green or brown, pruinose species often abundant on lowland fir in Oregon and California. *D. pacifica* (Wilson) attacks lowland fir in Northern California. *D. palmeræ* (Gill.) infests Engelmann and Parry spruces in Colorado. *D. picea* (Panzer) (*Lachnus vanduzei* Swain) is a very large, brownish species infesting spruce in California. *D. ponderosa* (Williams) occurs on yellow pine in Colorado and on Jeffrey pine in California and Nevada. *D. pseudotsugæ* (Wilson) is a brown species which infests the terminal shoots of Douglas fir in Oregon. *D. schwarzi* (Wilson) attacks yellow and other pines in Arizona and Colorado. **The arborvitæ aphis,** *D. tujafilinus* (Del G.) (Fig. 125), is a brown aphis with a beautiful pruinose pattern. It is a European species which infests the limbs of arborvitæ, Italian cypress, and retinospora, throughout California. *D. sabianianus* (Swain) occurs on digger pine in California. *D. taxifolia* (Swain) infests the trunks and branches of Douglas fir in California. *D. vandykei* (Wilson) occurs on spruce in Washington. *Schizolachnus piniradiatæ* (Davidson) (*Lachnus*) is a rather small, dark green, long-legged species entirely covered with cottony wax and inhabits the needles of Monterey and other pines in the San Francisco Bay region of California. *S. tomentosus* (De Geer) (*Lachnus pineti* Fabr.) varies from yellow to brownish black, covered with white secretion, and lives in "single file" on the needles of the Rocky Mountain yellow pine in Colorado.

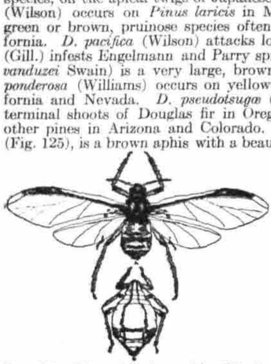

FIG. 125.—The arborvitæ aphis, *Dilachnus tujafilinus* (Del Guercio).

The giant willow aphis, *Pterochlorus viminalis* (Fonscolombe) (*Tuberolachnus*) [1] (Fig. 126), is one of the largest western aphis, measuring 4.2 x 2.1 mm. The color is brown with black spots, black cornicles, and a large black tubercle on the median dorsum just back of the middle. This conspicuous tubercle at once separates this giant species from all others. The surface is also covered with a fine, powdery white wax giving the body a decidedly gray color. It feeds in large, compact colonies on the trunks and branches of willows often near the ground, and when disturbed has the habit of kicking the hind legs back and forth above the abdomen in a very energetic manner. This habit is common to all the individuals of a colony and is probably a means of warding off natural enemies, although they are not exempt from the attacks of the larvæ of syrphid flies and hymenopterous parasites. It is known in Europe and various parts of the United States. In the west it is common in California and also occurs in Arizona and New Mexico. A disease which causes the bodies to melt away kills great numbers in Southern California. This aphis has recently been taken from Comice pear in California by the writer.

The oak bud aphis, *Thelaxes californica* (Davidson) (*Vacuna*), is a small gregarious species varying from yellow to dark green, less than 1 mm. long, which lives about the bases of the buds of the valley and bur oaks in Central California.

The woolly oak aphis, *Phyllaphis quercifoliæ* Gillette,[2] is yellow or pale green, partially or entirely covered with loose, wool-like, white wax. It infests the undersides of the leaves of the native scrub oak in Colorado. *P. quercicola* Baker is similarly covered with loose, cottony wax, and lives freely on the undersides of the leaves, or produces pseudogalls by turning under the edges of the leaves of the coast live oak in California. *P. fagi* (Linn.) is also dark green, covered with loose, white flocculence, and infests the undersides of the leaves of beech in California.

The manzanita leaf-gall aphis, *Tamalia coweni* (Cockerell) (*Phyllaphis, Pemphigus*),[3] is a very interesting species, producing numerous green or reddish roll galls on the edges of the leaves of manzanita. The adults inhabiting the galls are brownish or dark olive green with darker markings on the dorsum and vary from 1.5 to 2 mm. in length. The

[1] E. O. Essig, *P. C. Jour. Ent.*, 4, 1912, p. 774.
[2] C. P. Gillette, *Ent. News*, 25, 1914, p. 272. Orig. desc.
[3] E. O. Essig, *P. C. Jour. Ent. and Zoöl.*, 7, 1915, p. 187.

winged migrants are dark green and black. The males are winged and of the same color but very small, 0.85 x 0.30 mm. The distribution probably includes much of the west, but it is now known only in Colorado, Nevada, and California.

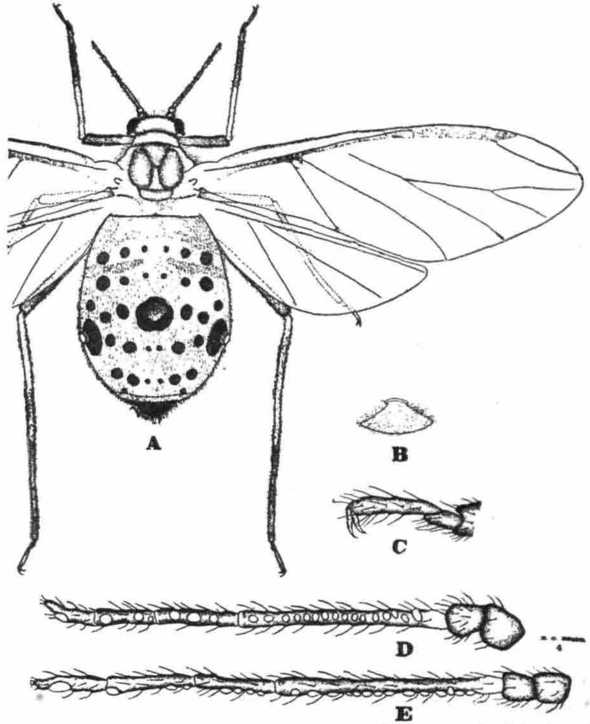

FIG. 126.—The giant willow aphis, *Pterochlorus viminalis* (Fonsc.). A, winged female; B, cornicle; C, tarsus; D and E, antennæ.

The common birch aphis, *Calaphis betulæcolens* (Fitch), is a large, green species with very short cornicles infesting the leaves of birch trees, producing quantities of honeydew, and causing much smutting of the foliage. All sexes appear and the eggs are laid in cracks of the bark and in the small crotches. It is generally distributed throughout the United States and is likely to occur wherever birches are grown. In the west it is recorded from Colorado and California. *C. annulata* (Koch) is a smaller, reddish-

brown species with many dark transverse bands on the dorsum. It is often associated with the former on birch in California.

The chestnut aphis, *Calaphis castaneæ* (Fitch) (*Myzocallis, Callipterus*), is a small pale yellow species often present in great numbers on the undersides of the leaves of chestnut and hickory trees. All sexes occur. It is an eastern species reported in the west only from California.

The walnut aphis, *Chromaphis juglandicola* (Kaltenbach)[1] (Fig. 130, A, B), is the pale yellow species so abundant on the undersides of the leaves of the English walnut trees throughout California and Oregon. The bodies of the nymphs are beset with long, glandular hairs and the apterous sexual females have two prominent black bands and smaller black spots on the dorsum. The species is often a serious pest to walnut trees and produces quantities of honeydew. The fungus, *Entomophthora chromaphidis* Burger

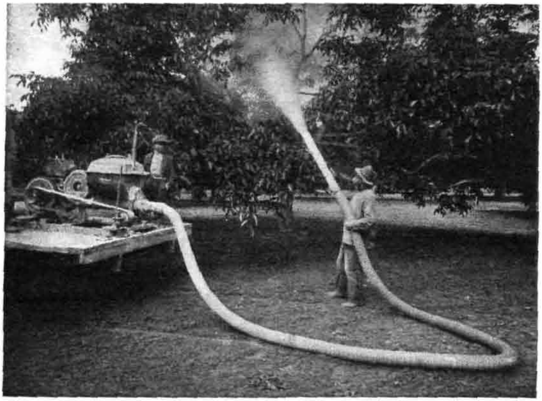

FIG. 127.—Applying nicodust in a walnut orchard with a power duster to control the walnut aphis, *Chromaphis juglandicola* (Kalt.). (Photo furnished by R. E. Smith.)

and Swain,[2] kills many of the aphis. It is easily controlled by dusting with very weak nicodust (Fig. 127), which readily adheres to the glandular body hairs and causes almost immediate death.

The cloudy winged oak aphis, *Therioaphis bellus* (Walsh) (*Callipterus*),[3] is a small, bright yellow species with black lines on the sides of the prothorax which extend slightly back of the bases of the front wings, and cloudy costal areas extending the full length of both pairs of wings. It is an eastern species, infesting the leaves of coast live oak in California and many species of oaks in the east. **The alder aphis,** *T. flavus* (Davidson)

[1] E. O. Essig, "The Walnut Plant Louse." *Mthly. Bul.*, Cal. State Com. Hort. 1, 1912, p. 190.
W. M. Davidson, *Walnut Aphides in California*. Bul. 100, U. S. Dept. Agr. 1914.

[2] *Jour. Econ. Ent.*, 11, 1918, p. 278.

[3] E. O. Essig, *P. C. Jour. Ent. and Zoöl.*, 7, 1915, p. 195.

(*Eucallipterus*), is a large, pale green species on the tender shoots of alder in California. **The linden aphis,** *T. tiliæ* (Linn.) (*Eucallipterus, Callipterus*), is a beautiful yellow and black species with clouded wings which has been introduced from the east and often becomes very abundant on linden trees in California. **The tan oak aphis,** *T. pasaniæ* (Davidson) (*Myzocallis*), is a yellow species occurring on the undersides of the leaves of the tan oak in California.

The European birch aphis, *Euceraphis betulæ* (Linn.), is a large green and black aphis distinguished from the common birch aphis by the flocculent waxy covering. It infests the leaves of all kinds of birch trees and occurs throughout the country. In the west it ranges from British Columbia to California and Colorado. *E. gillettei* Davidson is a large, pale green species, 3 mm. long, sparingly covered with white flocculence, and infests the undersides of the leaves of alder in California, and alder and birch in Colorado.

The wild walnut aphis, *Monellia californica* Essig,[1] is a beautiful, pale yellow species, 2 mm. long with a black band on each side of the prothorax, and with the veins, the tibiæ, and tarsi black. It occurs on the undersides of the leaves of California black walnut in Southern California. *M. caryæ* (Monell) is an eastern species which occurs on the eastern black walnut, hickory, and pecan in Oregon and California. **The little hickory aphis,** *M. caryella* (Fitch), is a common eastern species rarely taken on eastern black walnut in California.

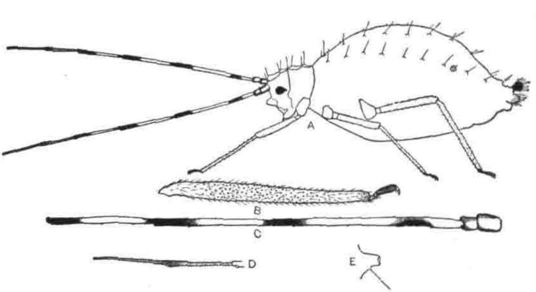

FIG. 128.—The bamboo aphis, *Myzocallis arundicolens* (Clarke). A, sexual female; B, hind tarsus of same; C, and D, antenna; E, cornicle.

The bamboo aphis, *Myzocallis arundinariæ* Essig and *M. arundicolens* (Clarke)[2] (Fig. 128), are common on the leaves of bamboo throughout California. Both species are yellow; the former has black markings on the head, antennæ, thorax, and abdomen, and is known only in the winged form, while the latter has black markings only on the antennæ in the winged females and has the sex forms, apterous yellow female and dark winged male. The eggs are first yellow, turning shining black. **The small alder aphis,** *M. alnifoliæ* (Fitch),[3] is an exceedingly small, pale yellow species 1.2 mm. long, often very abundant on the undersides of the leaves of alder in California. *M. castanicola* Baker (*M. davidsoni* Swain)[4] is a pale yellow species living on the undersides of the leaves of chestnut and oak in California. *M. californicus* Baker inhabits the valley oak in Central California. *M. maureri* Swain is dark green with clouded wings and infests the undersides of the leaves of live oak in California. **The locust aphis,**

[1] This species and *caryæ* (Monell) are placed with *caryella* (Fitch) in the genus *Monellia* by A. C. Baker and P. W. Mason.

[2] E. O. Essig, *Univ. Cal. Pub. Tech. Bul. Ent.*, 1, No. 7, 1917, pp. 302, 305.

[3] E. O. Essig, *P. C. Jour. Ent.*, 4, 1911, p. 764. *M. alni* (Fabr.).

[4] A. C. Baker, *Jour. Econ. Ent.*, 10, 1917, p. 424.

M. robiniæ (Gillette), is a pale yellow or greenish species with a dusky stigma in the wings. It occurs on the leaves of black locust in Colorado. **The elm aphis,** *M. ulmifolii* (Monell), is pale yellow or pinkish and infests the leaves of elms. It is a middle western species reported in Colorado and California.

The live oak bark aphis, *Symydobius agrifoliæ* Essig, is a robust, reddish-brown species infesting the twigs of the coast live oak in Southern California. *S. chrysolepidis* Swain is a similar species on interior live oak of Southern California. *S. macrostachyæ* Essig and *S. salicicorticis* Essig are brownish species feeding on the bark of willow, often at or just above the surface of the ground in Southern California.

The thrips aphis, *Thripsaphis balli* (Gillette) (*Brachycolus, Saltusaphis*), is a pale greenish, pruinose, long, slender, flat thrips-like species with short legs, living on grasses and sedges in Colorado. *T. producta* Gillette and *T. verrucosa* Gillette are closely related but darker species occurring on sedge in Colorado. *Saltusaphis flabellus* (Sanborn) (*Callipterus*) is a dark brown and black species also occurring on grasses and sedges in Colorado.

The maple aphis, *Drepanaphis acerifolii* Thomas (*Drepanosiphum*), is beautiful gray and black in the winged form and pale yellow in the apterous, and is easily distinguished by the large dark tubercles on the dorsum of the first and second abdominal segments of the winged migrant form. The males are winged while the sexual females are apterous and have an elongated ovipositor. It is a common eastern species, occurring more or less alone on the leaves of many species of maple throughout the west.

The sycamore aphis, *Drepanosiphum platanoides* (Schrank), is a very common, large, pale or dark green or reddish yellow species with the wing veins slightly dusky. The sexual forms are dark and the females have the tip of the abdomen much elongated. It infests maples and sycamores throughout the State and is of European origin. *D. braggi* Gillette is pale yellowish green and infests box elder in Colorado.

Chaitophorus agropyronensis Gillette is a green or yellowish flattened species living on smooth wheat grass in Colorado. *C. artemisiæ* Gillette is brownish black and infests artemisia in Colorado. *C. betulæ* Buckton infests white birch in Oregon and Colorado. *C. monella* (Essig) (*Micrella*) is a very small, pale green species on willow in California. *C. populifolii* (Essig) (*Eichochaitophorus, Arctaphis*) is a beautiful small pink or greenish species with mosaic-like markings on the dorsum. It is often abundant in great numbers on the undersides of the leaves of cottonwood in California. *C. viminalis* Monell is a dark species on willow in Colorado and has been confused with *Periphyllus salicicola* (Essig) in California.

The box elder aphis, *Periphyllus negundinis* (Thomas) (*Chaitophorus*), is a pale green, hairy eastern species infesting box elder. It occurs in Colorado, Utah, British Columbia, and California. *P. aceris* (Linn.) is recorded on maple in British Columbia. **The cloudy-winged cottonwood aphis,** *P. populicola* (Thomas) (*Chaitophorus, Thomasia*), is a dark species easily recognized by the clouded wing veins. It occurs on cottonwood and poplars in Colorado, Montana, Utah, California, and New Mexico. *P. crucis* (Essig) (*Chaitophorus*) and *P. salicicola* (Essig) (*Chaitophorus*) are common on the leaves of willow. The former is green with an indefinite, paler dorsal cross and the latter is very dark with a longitudinal, pale dorsal mark. The former occurs in Southern California, while the latter is common over the state.

The poplar bark aphis, *Pterocomma*[1] *populea* (Kaltenbach) (*Cladobius*), is a long, dark species with orange-colored, short, cylindrical cornicles. It feeds on the bark of poplar in British Columbia. *Melanoxantherium beulahensis* (Cockerell) (*Cladobius*) is a brown species with orange, slightly swollen cornicles which are much more than twice as long as wide. It infests twigs of aspen in New Mexico. *M. flocculosum* (Weed) (Fig. 129) is a large, brown species with two rows of black spots on the dorsum almost entirely covered with loose, flocculent, white wax, and with orange cornicles abruptly constricted at the extremities and without a distal flange. It feeds on the bark of willows in Oregon and California. *M. populifoliæ* (Fitch) (*M. rufulum* Davidson) has bright orange cornicles longer than twice the greatest diameter and nearly twice the length of the hind tarsi. It infests willows from Alaska to California. *M. smithiæ* Monell has bright orange cornicles much swollen in the middle and more than twice as long as the hind tarsi. It infests willows and poplars and is known in British Columbia, Colorado, and California.

Fullawaya saliciradicis Essig is a large, brown species devoid of cornicles which occurs on the roots of willows in Southern California.

[1] A. C. Baker, "A Review of the *Pterocommini*." *Can. Ent.*, 48, 1916, p. 280.

The clover aphis, *Anuraphis bakeri* (Cowen) (*Aphis*),[1] is variable in color; the spring stem-mothers are pink or reddish, often mottled green; the winged migrants vary from yellowish green to reddish, with head and thorax black; the fruit tree inhabiting forms are yellowish green with an orange spot surrounding each cornicle. It is primarily a clover-infesting

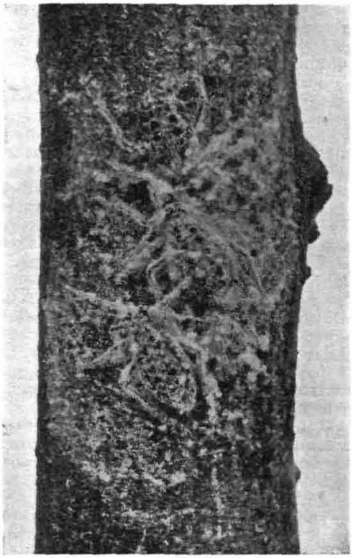

FIG. 129.—The cottony willow aphis, *Melanoxantherium flocculosum* (Weed). Characteristic colony partially hidden beneath the white cottony wax.

species and may spend the entire year on this plant or it may spend the summer on clover and other succulent plants and lay the overwintering eggs on apple, pear, quince, hawthorn, and similar trees, the spring forms leaving for clover, alfalfa, and shepherd's purse, in early summer. In some sections it causes serious losses to the clover seed crop in Oregon, Idaho, and Colorado. The distribution includes much of the United States

[1] C. P. Gillette, Bul. 133, Colo. Agr. Exp. Sta. 1908, p. 28; *Jour. Econ. Ent.*, 11, pp. 328–333, 1918.
R. H. Smith, *Research Bul.* 3, Idaho Agr. Exp. Sta. 1923. (Complete Biology, Control, etc.)

and all of the west. The fungus, *Entomophthora aphidis* (Hoffm.), is effective during the winter and early spring and kills many of the lice.

The thistle aphis, *Anuraphis cardui* (Linn.) (*Aphis*, *A. pruni* Koch), is a fairly large, shiny, green species with black dorsal markings, which spends the summer on thistles, chrysanthemum, malva, senecio, and shepherd's purse, and normally winters on apricot, plum, and prune. In California it also often passes the winter on thistles, omitting the egg stage.

The hawthorn aphis, *Anuraphis cratægifoliæ* (Fitch) (*Aphis*), is a pale or dark green species which infests the undersides of the leaves of English hawthorn in California. It is a common eastern species.

The leaf curl plum aphis, *Anuraphis helichrysi* (Kalt.) (*Aphis*,[1] *A. senecio* Swain), is a pest of prune and plum in some of the Western States. The summer forms are pale green; the oviparous females green to reddish brown, and the stem-mothers dark green or reddish with brown dorsal bands. The winter is spent chiefly on plum and prune and these are often severely attacked in the spring and summer. The other summer hosts are amsinckia, anthemis, aster, carrot, chapparal broom, chrysanthemum, cineraria, clover, dahlia, erigeron, eupatorium, goldenrod, heliotrope, lithospermum, malva, marguerite, nettle, onosmodium, phacelia, ragweed, senecio, shepherd's purse, sunflower, tansy, thistles, and yarrow. The distribution in the west includes Washington, Idaho, Oregon, California, Nevada, Utah, and Colorado. It is chiefly injurious in Idaho and Colorado.

The tulip or iris root aphis, *Anuraphis tulipæ* (Fonsc.) (*Aphis iridis* Del Guercio), is a pale whitish, pulverulent species, with black head and thorax in the winged forms. It infests chiefly the bases of the plants at or below the surface of the ground and also occurs on the roots, the flower stems, beneath the leaf sheaths, and the seed pods, if a hiding place is available. All varieties including beardless, bearded, bulbous, and wild irises and tulips and other bulbs are infested, and the aphis continues to feed and breed on cured and stored rhizomes and bulbs as long as there is any vitality left. It is a European species which has been carried over the country on tulips, iris plants, and bulbs, and is easily overlooked because of its secretive nature in hiding under the leaf sheaths or bulb scales. In California it is common throughout the State. P. W. Mason and A. C. Baker consider the tulip and iris infesting forms the same and kindly verified our western species. Control in the field is seldom necessary but if so, heavy applications of nicodust in the crowns of the plants are effective. Infested rhizomes and bulbs should be soaked for several hours in 1 part of 40-per cent nicotine sulfate solution to 1,000 parts of water, or thoroughly covered for a like period in 2 per cent pure nicodust.

The corn root aphis, *Anuraphis maidi-radicis* (Forbes) (*Aphis*), is a serious pest of corn in the Middle States and is reported as far west as Colorado by C. P. Gillette, who has taken it on the roots of corn, oxeye daisy, chrysanthemum, helianthus, and rhubarb. It is not known elsewhere in the west unless it is confused with **the aster root aphis,** *Anuraphis middletoni* (Thomas) (*Aphis*), which is also a pale or light gray or very dark green species common throughout California on the roots of asters, buttercup, cosmos, dahlia, erigeron, ironwood, nightshade, pigweed, thistle, and various other composite flowers and weeds.

[1] R. H. Smith, *Jour. Econ. Ent.*, 14, 1921, p. 422.

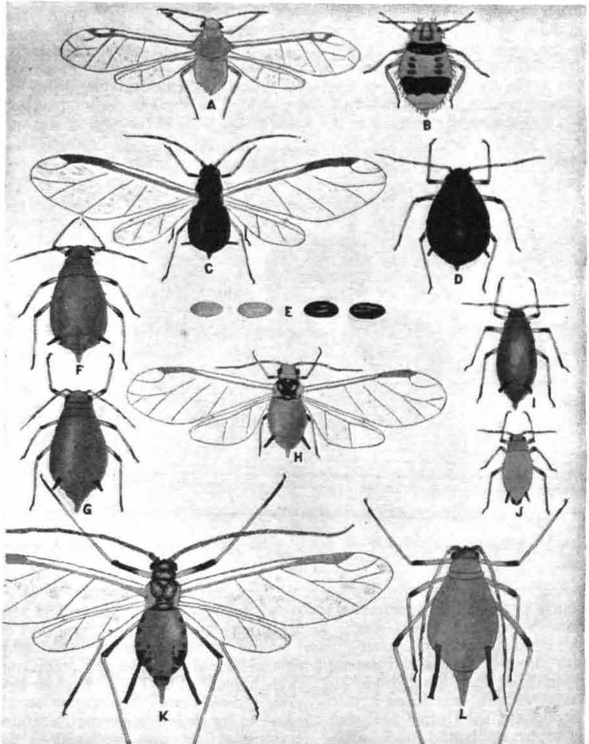

FIG. 130.—Aphis or plant lice. A, winged parthenogenetic female, and B, apterous sexual female of the walnut aphis, *Chromaphis juglandicola* (Kalt.); C and D, the black citrus aphis, *Toxoptera aurantiæ* Koch; E, eggs; F, stem mother; G, apterous parthenogenetic female; H, winged migrant; I, sexual female; J, male of the green apple aphis, *Aphis pomi* De Geer; K and L, the rose aphis, *Macrosiphum rosæ* (Linn.).

The rosy or purple apple aphis, *Anuraphis roseus* Baker (*Aphis malifoliæ* Fitch, *A. sorbi* Kalt.)[1] (Fig. 131), is one of the most injurious apple aphis in the west. The apterous forms vary from rosy to purplish and the winged forms are of the same color with the head and thorax black. The bodies are often covered with a fine whitish powder. The aphis winters over on the apple and feeds on the fruit and foliage until midsummer when the winged migrants leave the fruit trees to feed on the ribgrass or plantain, the late migrants returning to the apple in the late fall for mating and egg-

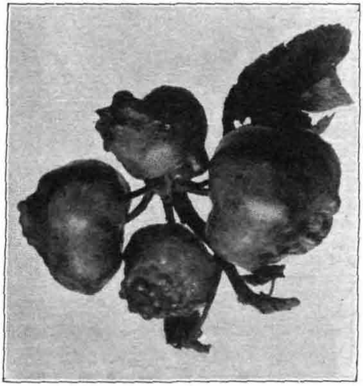

FIG. 131.—Stunted apples due to the attacks of the rosy or purple apple aphis *Anuraphis roseus* Baker.

laying, while a few may live over on the plantain and migrate to other plants in the spring or summer quite independent of the apple. The eggs hatch when the leaf buds begin to open, and the young enter and feed on the developing leaves causing them to curl in ugly masses. The aphis also infest the young developing fruit causing deformation and premature ripening or what the growers call "aphis apples" (Fig. 131). Very serious losses are thus occasioned both to young and old trees. The species occurs throughout the United States and is known by such other common names as brown aphis and black aphis. In the west it is most serious along the Pacific slope in British Columbia, Washington, Oregon, and California, but is also present in Idaho and Colorado. Control measures consist in spraying with dormant lime-sulfur when the buds are swelling, or with soap or soap-tobacco solutions after the leaf buds open and until they are one-half inch long; or by thoroughly and frequently dusting with nicodust

[1] H. F. Wilson, *Bien. Crop Pest and Hort. Rept.*, 1911–12, Ore. Agr. Exp. Sta. 1913, p. 82.
E. O. Essig, *Inj. and Ben. Ins.*, 2d ed. 1915, p. 95.
A. C. Baker, *Jour. Agr. Research*, 7, No. 7, 1916. *Can. Ent.*, 53, 1921, p. 95.

or with sulfur-nicodust which appears to give some results in controlling apple mildew as well as the aphis. It is also possible to secure beneficial results by spraying or dusting in November and later to kill the migrants and sexual forms on the fruit trees at that time and thus reduce the numbers of overwintering eggs.

The black peach aphis, *Anuraphis persicæ-niger* (Smith) (*Aphis*) (Fig. 132), is a shiny black species, the immature forms of which are reddish brown. It infests the roots, tender shoots and fruit of peaches, almonds, and apricots, and the tender shoots of plums grafted on peach roots. It is distributed throughout California, Oregon, Utah, New Mexico, Idaho,

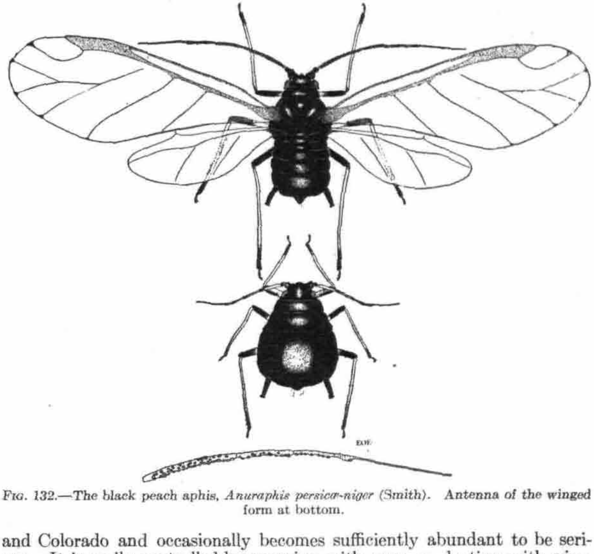

FIG. 132.—The black peach aphis, *Anuraphis persicæ-niger* (Smith). Antenna of the winged form at bottom.

and Colorado and occasionally becomes sufficiently abundant to be serious. It is easily controlled by spraying with soap or dusting with nicodust. Paradichlorobenzene is successful for treating the root-infesting forms.

The elder aphis, *Anuraphis sambucifoliæ* (Fitch) (*Aphis*), is a dull black form often very abundant on the undersides of the leaves of elder. The sexual females are very small and amber or brownish in color. It is an eastern species common in California. **The snowball aphis,** *Anuraphis viburnicola* (Gillette) (*Aphis*), is a dull black aphis common in the spring and again in the fall on snowball in Colorado.

The spruce aphis, *Aphis abietina* Walker (*Myzaphis*), is a small, deep green aphis living on the older needles of Norway and Sitka spruces in the spring and early sum-

mer, often causing the needles to turn yellow and fall. It leaves during the summer for alternate summer hosts which are unknown, and ranges from British Columbia to California. **The snowberry aphis,** *Aphis albipes* Oestlund (Fig. 133), is a very pretty grayish species with one or two pale transverse bands and one longitudinal dorsal band. It feeds on the leaves of snowberry in California and Colorado. *Aphis pulverulens*

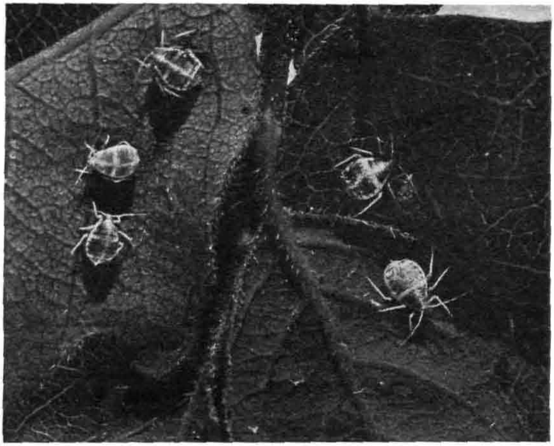

FIG. 133.—The snowberry aphis, *Aphis albipes* Œstlund. Apterous forms.

Gillette is greenish brown and covered with a silvery white secretion or with woolly or cottony wax. It infests the stems of snowberry at or below the surface of the ground in Colorado.

The anise aphis, *Aphis cari* Essig, is a pale yellowish green species with darker green markings which infests wild anise and angelica in California. **The ceanothus aphis,** *Aphis ceanothi* Clarke (*A. ceanothi-hirsuti* Essig), is a reddish brown and black species often present in great numbers on the limbs, twigs, and leaves of ceanothus and soap-bush in California. **The choke cherry aphis,** *Aphis cerasifoliæ* Fitch, is a pale green, slightly pulverulent species with dark median and transverse darker markings in the apterous form, and is bright green and black in the winged migrant. It infests and often curls the leaves of choke cherry, wild cherry, and wild plum throughout the country. In the west it is recorded in British Columbia, California, and Colorado, and often occurs at high altitudes. **The dogwood or sunflower aphis,** *Aphis cornifoliæ* Fitch (*A. helianthi* Monell, *A. gillettei* Cowen), is a brown and black or very dark green and black species often somewhat pulverulent, which according to C. P. Gillette[1] passes the summer on the leaves of wild and cultivated sunflowers and migrates to dogwood in mid-August to give rise to sex forms, the females of which lay the overwintering eggs. In summer the winged forms migrate back to sunflowers as well as to poverty weed (*Iva*), wild currant, and snake root. It is a common species throughout the United States and occurs in Oregon, California, and Colorado in the west. **The dodder aphis,**

[1] *Jour. Econ. Ent.*, 3, 1910, p. 406. Also see article by J. J. Davis, *Jour. Econ. Ent.*, 3, 1910, p. 485.

Aphis cuscutæ Davis,[1] is pale green, somewhat pulverulent, the winged forms with three dusky spots on each side in front of the cornicles. It infests dodder growing in alfalfa fields in Utah.

The cotton or melon aphis, *Aphis gossypii* Glover [2] (Fig. 134), is a small species usually very dark green in color or varying from yellowish to dark green, brown, or black, the paler forms with darker mottlings on the dorsum. In a few cases the nymphs and adults are covered with fine or rather thick cottony wax.[3] The melon aphis is cosmopolitan and generally distributed over the southern part of the United States and is a serious pest of melons in many sections. In the Southern States, Arizona, and California it commonly feeds on cotton and is known as the cotton aphis, while in Southern California it commonly attacks the tender shoots of orange

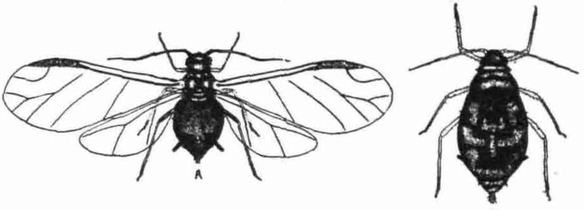

FIG. 134.—The cotton or melon aphis, *Aphis gossypii* Glover.

trees and is called the orange aphis. In the west it occurs in practically every State and attacks a wide variety of plants including anthemis, asparagus, avocado, begonia, buckthorn, California poppy, cantaloupe, cattail, catalpa, chrysanthemum, citron, cotton, cucumber, dock, dogwood, gourd, grapefruit, hop, hydrangea, ironwood, Jimpson weed, lambsquarters, lemon, malva, milkweed, morning glory, muskmelon, orange, wild parsnip, pear, peppergrass, pigweed, plantain, pomegranate, rose, shepherd's purse, spinach, sugar beet, sunflower, syringa, thistle, and watermelon. In the west and particularly in the southwest, the melon aphis appears to omit the sexual forms and to hibernate in the winged and wingless stages on weeds and cultivated plants, and reproduces very rapidly as soon as summer approaches, consequently breaking out of a sudden in the melon and cotton fields and orchards. There is a host of natural enemies for this aphis. For many years the state insectary in California shipped great numbers of the ladybird beetle, *Hippodamia convergens* Guér., to the Imperial Valley to prey upon it. The most satisfactory artificial control consists in two applications of 2 per cent pure nicodust, using from 30 to 50 pounds per acre at each application (Fig. 135). Nicotine sprays are also

[1] J. J. Davis, *Can. Ent.*, 51, 1919, p. 229. Orig. desc.
[2] E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 89.
F. B. Paddock, *The Cotton or Melon Aphis.* Bul. 257, Texas Agr. Exp. Sta. 1919.
[3] *Aphis cooki* Essig may yet prove to be but a form of *Aphis gossypii* Glover. It has been taken only once on orange trees regularly infested with the latter.

effective but slower and much more difficult of thorough application. In the cantaloupe and melon fields it is a good practice to remove and burn the few severely infested plants as they appear in the spring, to prevent rapid spreading.

The gooseberry aphis, *Aphis grossulariæ* Kalt., is a dark green and black pulverulent species often abundant on the tender shoots of gooseberries in Oregon.

The ivy aphis, *Aphis hederæ* Kalt., is a very dark purplish or olive green or brownish black species occurring on the tender growing tips of English ivy throughout California. Some forms are also pulverulent. **The wild parsnip aphis,** *Aphis heraclella* Davis (*A. heraclei* Cowen), is a dark green species with green and reddish mottlings on the dorsum and is often very abundant on the old leaves of wild parsnip and angelica in California.

The corn aphis, *Aphis maidis* Fitch, is a small, dark green species which is common on the leaves, ears, and tassels of corn and sorghums in Cali-

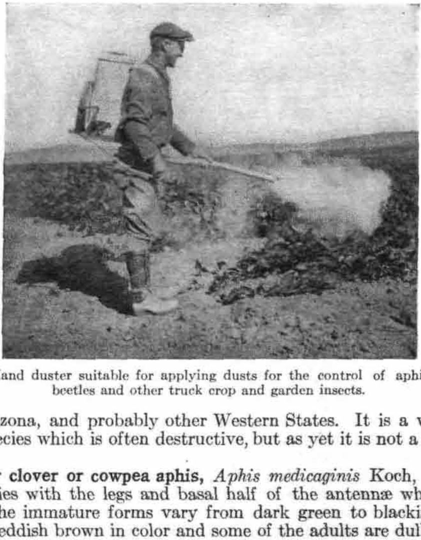

FIG. 135.—Hand duster suitable for applying dusts for the control of aphis, thrips, flea beetles and other truck crop and garden insects.

fornia, Arizona, and probably other Western States. It is a well known eastern species which is often destructive, but as yet it is not a pest in the west.

The bur clover or cowpea aphis, *Aphis medicaginis* Koch, is a shiny black species with the legs and basal half of the antennæ white or pale yellow. The immature forms vary from dark green to blackish; or they are often reddish brown in color and some of the adults are dull black. It is a European species rather common in some parts of Colorado, New Mexico, Texas, Arizona, and California, feeding chiefly on legumes but also taken on a wide variety of plants including alfalfa, apple, bean, caragana, clover, cowpea, dandelion, dock, eucalyptus, lambsquarters, wild licorice, locoweed, clammy locust, false mallow, meadow grass, melilotus, mustard, opuntia, orange, pear, peppergrass, primrose, rhu-

barb, senna, shepherd's purse, sophora, and tansy. No sex forms have been observed in the west. In the southwest it passes the winter on clover, melilotus, alfalfa, and opuntia. In Colorado it may appear on the tender shoots of apple and pear in the spring.

The oleander and milkweed aphis, *Aphis nerii* Fonscolombe (*A. lutescens* Monell) (Fig. 136), is a very pretty, bright yellow and black species, appearing on the tender shoots of the oleander in the spring and early summer. When the milkweeds appear, the winged forms migrate to them and succeeding broods remain until the plants dry up in the fall when the return migration to the oleander takes place. It also appears

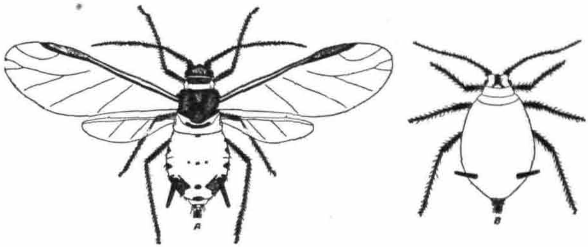

FIG. 136.—The oleander or milkweed aphis, *Aphis nerii* Fonsc.

to be able to maintain itself on oleander independent of the milkweed. It is a European species which occurs throughout the country and is common in California and also occurs in New Mexico.

The evening primrose aphis, *Aphis œnotheræ* Oestlund, is a small, robust, dark green, pulverulent species often very abundant on the floral heads of the cultivated and wild, species of evening primrose in California. It is a well known eastern species.

The green apple aphis, *Aphis pomi* De Geer [1] (Fig. 130, E–J), is a close second to the rosy apple aphis as a pest to apple trees in the west. It has a wider distribution and greater range of food plants, and in some places is a more destructive pest. The entire life-cycle is usually passed on a single host and represents very well the life history of a species which does not have alternate host plants. All forms are small and usually bright, rich green in color. The summer forms consist of apterous and winged parthenogenetic females which reproduce their kind until fall. They feed on the tender tips, undersides of the leaves, and on the developing fruit. In the late fall, October and November, the small, dusky, yellow, wingless males and normal sized, dark green, wingless females appear and mate, the females laying from two to six fertile eggs each. The eggs are tiny, oval, pale yellow or green when first deposited and soon turn shining black and almost always occur in great numbers on the twigs of the current year's growth and around the fruit spurs (Fig. 137). They survive the winter

[1] C. P. Gillette, Bul. 132, Colo. Agr. Exp. Sta. 1908, p. 23. Also *Jour. Econ. Ent.*, 3, 1910, p. 404.

A. C. Baker and W. F. Turner, "Morphology and Biology of the Green Apple Aphis. *Jour., Agr. Research*, 5, 1916, p. 955.

and begin to hatch the following spring when the leaf buds are opening and are usually all incubated by the time the young leaves are one-half inch long. The young, very dark green lice enter the unfolding buds and feed on the leaves. They reach maturity in two or three weeks and are all apterous females capable of reproduction without mating and are called stem-mothers. They give rise to the first generation or brood, the individuals of which are bright green and nearly all wingless, a very few winged forms appearing. They mature in two or three weeks and are likewise parthenogenetic females and give rise to both apterous and winged individuals which in turn give rise to other broods of the same kinds. Thus successive broods appear throughout the summer, there being six to eight in all. The apterous forms remain close to the parents, while the winged migrants fly away to found new colonies. With the coming of winter there is a rapid decrease in the numbers of the summer forms which entirely disappear after the birth of the sexual males and females. The green apple aphis is a European species which has been carried in the egg stage on nursery stock and probably occurs wherever apples, pears, hawthorns, and other hosts, are grown throughout the world. In the west it is known in British Columbia, Washington, Idaho, Montana, California, Nevada, Utah, Arizona, and Colorado. The chief food plant is the apple, the tender shoots of which are infested, the leaves curled, fruit dwarfed, and the entire tree often severely injured. The young shoots of cotoneasters, English hawthorn, loquat, pears, pittosporum, pyracantha, and quince are also infested. There are numerous predaceous and parasitic enemies including the larvæ of the green lacewing, the syrphid flies, the larvæ and adults of many ladybird beetles, and the internal parasites. Control measures are the same as those recommended for the rosy or purple apple aphis.

FIG. 137.—Eggs of the green apple aphis, *Aphis pomi* De Geer, on a small apple twig. Greatly enlarged.

The black sage aphis, *Aphis ramonæ* Swain, is a very small dull black species often present in great numbers on the tips of wild black sage in Southern California.

The bean or dock aphis, *Aphis rumicis* Linn.[1] (*A. euonymi* Fabr.),[2] is one of the commonest dull black species occurring throughout the Western States. It has alternate host plants, wintering on euonymus and dock, and migrating to the following plants as summer hosts; globe artichoke, asparagus, atriplex, bean, broad bean, blackeye bean, beets, broom, burdock, cowpeas, dahlia, genista, lambsquarters, nasturtium, nettle, parsnip, pea, pigweed, poppy, shepherd's purse, spinach, thistles, vetch, and watercress. *Aphis carbocolor* Gillette is a black species which infests dock in Colorado.

[1] J. Davidson, "Biology of *Aphis rumicis* Linn." *Annals Applied Biol.*, 1, 1914, p. 118; 8, 1921, p. 51; 9, 1922, p. 135; 10, 1923, p. 35.

[2] A. F. Swain, *Univ. Cal. Pub. Tech. Bul. Ent.*, 3, 1919, p. 101.

The willow aphis, *Aphis saliceti* Kalt. (*Siphonophora salicicola* Thos.), is a deep green species infesting the willow. The sex forms are apterous and appear early in summer in Colorado and in September in California. The tiny males are bright orange and the females dark green. **The thistle red aphis,** *A. torticauda* Gillette, is a large, red species infesting thistles in Colorado.

The knotweed aphis, *Aspidaphis polygoni* Gillette, is pale yellowish or green and infests knotweed in Colorado.

The small green rose aphis, *Myzaphis rosarum* Walker, is easily distinguished from the rose aphis by its very small size and green or green and black color with the absence of pink forms, and by the fact that it is more often found on all parts of the plants including the undersides of the leaves and not limited to the tender shoots and buds. It is often a very serious pest of roses in California and occurs also on roses in Oregon and Colorado. In the latter State C. P. Gillette also records it on strawberry and cinquefoil.

The grindelia aphis, *Atarsos grindeliæ* Gillette, is dull brown or dark green and lacks tarsi in all stages. It infests *Grindelia squarrosa* Dunal in Colorado.

The western wheat aphis, *Brachycolus tritici* Gillette,[1] is a slender, pulverulent species, the apterous forms yellow or pale green and the winged forms green and black. The sexual forms are apterous and pale yellow. The eggs are laid on the blades and stems of fall seeded wheat or barley, or on volunteer grains and wild grasses. They hatch in April and the stem-mothers bring forth young in two or three weeks. Winged migrants appear by the middle of June and disappear by the middle of August. The sex forms appear in October and may remain until the first of December. The aphis stunt the plants and are usually injurious in fields previously summer fallowed where volunteer grain and grasses have been allowed to grow. The food plants are barley, wheat, blue stem, blue joint and spear grasses, cheat, and timothy. The distribution includes Montana, Wyoming, and Colorado. Control measures consist in clean summer fallow.

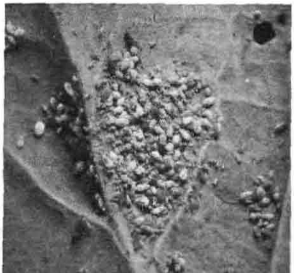

FIG. 138.—The cabbage aphis, *Brevicoryne brassicæ* (Linn.). Typical colony on cabbage leaf.

The cabbage aphis, *Brevicoryne brassicæ* (Linn.) (*Aphis*) (Fig. 138), is a very common cosmopolitan species occurring wherever cabbage and related plants are grown. The apterous forms are pale green with brownish transverse markings and the winged forms are dull green and black. All are covered with a fine, whitish powder

[1] J. R. Parker, *Jour. Econ. Ent.*, 9, 1916, p. 182.

which gives them a decided mealy appearance. No sex forms have been observed by the writer, although eggs are reported in British Columbia. The parthenogenetic females continue throughout the year in compact colonies on nearly all wild and cultivated cruciferous plants as broccoli, cabbage, cauliflower, isatis, kale, kohl-rabi, mustard, radish, rutabaga, and shepherd's purse.

The rusty plum aphis, *Hysteroneura setariæ* (Thomas) (*Aphis, Heteroneura*), is a rusty brown species common on plums in the east and middle States, and ranging into Colorado. It also feeds on corn, grasses, sugar cane, and Virginia creeper.

The water aphis, *Hyadaphis aquatica* (Gillette and Bragg) (*Siphocoryne*), inhabits water grass in Colorado. The apterous females are pale green and the winged forms green and black. *H. essigi* (Gillette) (*Siphocoryne*) [1] is a bright green and green and black species with pre-caudal spine. It is often very abundant on willow in California. *Cavariella capreæ* (Fabr.) (*Aphis, Siphocoryne*) is much like *H. essigi* (Gillette), bit. has a shorter terminal antennal spur. It also infests willow as well as dog fennel, anise, and water hemlock in California and Colorado. *C. pastinacæ* (Linn.) (*Siphocoryne xylostei* Schrank, *S. conii* Davidson, *Hyadaphis umbellulariæ* Davidson) is a much confused species resembling the previous form but lacking the pre-caudal spine. It feeds on California laurel, honeysuckle, water hemlock, and wild parsnip.

The mealy plum aphis, *Hyalopterus arundinis* (Fabr.) (*Aphis pruni* Fabr.), is a pale green pulverulent species which winters on plums and prunes and becomes very abundant on the undersides of the leaves and on the tender tips, and is responsible for much injury to the tree, causing end splitting of the fruit of prunes. Usually during July it migrates from the fruit trees to reed grasses and cat-tails along the rivers, although a few stragglers may persist on the fruit trees until fall in California. In the late fall or early winter there is a return migration to the fruit trees where the sex forms lay the overwintering eggs. In many sections of California apterous females hibernate on reed grasses and cat-tails and the succeeding winged forms migrate to the orchards in early summer and others return to these plants again in late fall. The mealy plum louse is a European species distributed to many parts of the world. In the west it is recorded in British Columbia, California, Nevada, Utah, and Colorado, and undoubtedly occurs in adjacent States. The winter-spring hosts are plum, prunes, apricot, apple, peach, and reed grasses, and cat-tails. The Japanese hybrid plums are apparently immune. The summer hosts are reed grasses and cat-tails. A spray composed of 5 pounds of soap, 1 gallon of miscible oil, and 100 gallons of water gives good control. *Hyalopterus atriplicis* (Linn.) (*Aphis*) is a pale green species covered with a fine, white powder, which occurs on various species of lambsquarters, beet, and dock in Oregon, California, and Colorado.

The barberry aphis, *Liosomaphis berberidis* (Kalt.) (*Aphis*), is usually pale yellow or greenish, the winged forms with the usual darker markings. The apterous sexual females appearing in the fall have conspicuous, transverse black markings on the dorsum. The species occurs in large numbers on the undersides of the leaves of barberry and Oregon grape in California. The winter is passed in both the egg and agamic forms.

Howard's aphis, *Liosomaphis howardi* (Wilson) (*Amphorophora, Rhopalosiphum*),[2]

[1] C. P. Gillette, *Can. Ent.*, 50, 1918, p. 94. This species was previously described by the writer as *H. pastinacæ* (Linn.).

[2] J. J. Davis, *Can. Ent.*, 46, 1914, p. 165.

is a rather large species varying from amber to shining, dark reddish brown or almost black. It infests barley, oats, wheat, and wild grasses in California and Utah. *L. rhois* (Monell) is very close if not identical with the preceding. It has been taken by C. P. Gillette on barley, oats, timothy, wheat, wild rye, and sumach in Colorado,[1] and on poison oak in California.

The apple-grain aphis, *Rhopalosiphum prunifoliæ* (Fitch) (*Aphis*),[2] is one of the commonest pests in Europe and North America. The wingless agamic females are usually pale green, often with three darker, longitudinal lines on the back, and with short, swollen cornicles. Orange markings about the bases of the cornicles appear usually only in the spring forms. The winged forms have dark markings. The sexual females are apterous and pale green, the males are of the same color and winged. In the colder regions the winged migrants on grains and grasses return to the apple, pear, quince, and other rosaceous plants and produce the sexual forms, the females of which lay the overwintering eggs. In the spring the first broods feed on the fruit trees, but the migrants early leave for various grains, grasses, and weeds, where the summer is spent. In the milder regions of Oregon, California, Arizona, and New Mexico the entire year may be spent on grasses, the winter forms living in the crowns near the roots. Fall and winter sown barley and other grains are often severely injured in the Imperial Valley, California, and in Arizona. Among the winter hosts are apple, choke cherry, wild black cherry, dogwood, hawthorn, pear, plum, and quince. Of these the apple is the most preferred. The leaves are curled and the trees often seriously injured, particularly in the northern and colder States. The summer hosts are chiefly wild grasses of which there are many, but also include barley, burdock, cat-tail, celery, corn, Johnson grass, oats, rye, wild rye, shepherd's purse, sorghums, timothy, and wheat. It occurs in every Western State and is a more serious pest of grains and grasses than of fruit trees. Control measures consist in the alternation of crops and clean culture.

The water lily aphis, *Rhopalosiphum nymphææ* (Linn.), is variable in size and color. The forms infesting water plants are usually small and dull, or shining dark green or brownish black, while those infesting fruit trees are large, reddish brown, covered with whitish powder. The summer hosts are water lily, water plantain, cat-tail, pondweed, and knotweed. Winged migrants seek almond, apricot, or plum in the fall where the apterous females and winged males are produced and the overwintering eggs deposited. The early spring forms are reddish and feed on the bark of the small shoots of the fruit trees. It is quite common in various parts of the United States, often abundant in California, and undoubtedly occurs in other Western States as well. *R. poæ* Gillette is dusky brown to blackish with pale cornicles. It infests lawn and wild grasses in Colorado and New Mexico.

[1] *Jour. Econ. Ent.*, 8, 1915, p. 100.

[2] This species has long been confused with the true European oat aphis, *A. avenæ* Fabr., and is so referred to in our literature. The latter rarely, if ever, occurs in this country.

C. P. Gillette, Bul. 132, Colo. Agr. Exp. Sta. 1908, p. 30.

J. J. Davis, Bul. 112, U. S. Dept. Agr. 1914.

A. L. Quaintance and E. H. Siegler, *Farmers' Bul.* 1270, U. S. Dept. Agr. 1922, p. 25.

The turnip aphis or false cabbage aphis, *Rhopalosiphum pseudobrassicæ* (Davis) (*Aphis*),[1] is a greenish species covered with a white bloom similar to the common cabbage aphis. It is easily separated by the presence of sensoria on the fourth antennal segment of the winged forms. The host plants are cabbage, cauliflower, collards, kale, kohl-rabi, mustard, radish, rape, rutabaga, turnip, bean, and lettuce. The distribution is general throughout the United States. In the west it is recorded in Washington and California.

The cypress aphis, *Siphonatrophia cupressi* (Swain) (*Cerosipha*), is a rather large, green aphid with convex abdomen, large cauda and very short cornicles. It infests the blue cypress and Monterey cypress in Southern California.

The black citrus aphis, *Toxoptera aurantiæ* Koch[2] (Fig. 130, C. D.), is a small dull or shiny black or brownish species easily distinguished by the black stigma and the single branched media vein in the wings. The species is common in Southern California and ranges as far north as the San Francisco Bay region. It feeds chiefly on citrus trees, but also infests camellia and various tropical plants.

The green bug, *Toxoptera graminum* Rondani,[3] is a medium sized, pale green species with darker green, longitudinal stripes and black-tipped cornicles. It is easily distinguished from all other grain and grass-infesting species by the single branched third discordal or media vein. It occurs throughout the country and is reported in every Western State, excepting Oregon, by Webster and Phillips. In California it was first taken by C. M. Packard on barley at Lancaster in March, 1926. New Mexico is the only Western State where the aphis is noted as being a serious pest. The hosts are various wild grasses, barley, blue grass, Bermuda grass, Johnson grass, buckwheat, alfalfa, corn, oats, rye, wild rye, spelt, and wheat. In the Northern States the overwintering eggs are laid chiefly on the blue grass and other wild grasses and the spring forms migrate to the grain fields, while in the southern areas the egg-laying females are omitted in the life history and breeding is almost continuous. The most important method of control is to destroy all volunteer grain, particularly oats and wheat from midsummer to fall.

The wild rose aphis, *Amphorophora nervatum* (Gillette) (*Rhopalosiphum, R. arbuti* Davidson), is a fairly large, green or pink and black species with dusky wing veins, common on the buds and tips of wild and cultivated roses in Colorado and on the tender shoots of the California Christmas berry, madrona, manzanita, and strawberry tree in California. *A. corylinum* (Davidson) (*Rhopalosiphum*) is a pale green species

[1] J. J. Davis, *Can. Ent.*, 46, 1914, p. 231.
J. J. Davis and A. F. Satterthwait, Bul. 185. Purdue Agr. Exp. Sta. 1916.
F. B. Paddock, Bul. 180, Texas Agr. Exp. Sta. 1915. Also *Jour. Econ. Ent.*, 9, 1916, p. 67.
A. L. Melander and M. A. Yothers, Bul. 127, Wash. Agr. Exp. Sta. 1917.

[2] E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 78. This species is also listed as *T. aurantii* Fonsc.
W. J. Phillips and J. J. Davis, Tech. Ser. No. 25, pt. 1, Bur. Ent. U. S. Dept. Agr. 1912, p. 8.

[3] S. J. Hunter, "The Green Bug and Its Natural Enemies." *Bul. Univ. Kan.*, 9, No. 2, 1909.
F. M. Webster and W. J. Phillips, Bul. 110, Bur. Ent. U. S. Dept. Agr. 1912.
W. R. Walton, *Farmers' Bul.* 1217, 1921.

infesting the tips of wild hazel in Central California. *A. lactucæ* (Kalt.) is a green and black species which overwinters in the egg stage on wild and cultivated currants and gooseberries, and passes the summer on wild lettuce, chicory, sow thistles, and celery, in Colorado and California. In California young and adults also occur throughout the winter on sow thistles. *A. rubi* (Kalt.) is a large, green species infesting the terminal shoots of wild and cultivated blackberries, raspberries, loganberries, and thimbleberries in California and Colorado. **The thimbleberry aphis,** *A. rubicola* (Oestlund) (*Nectarosiphum*), is a beautiful large, pale yellowish green apterous form, while the winged migrants and males are pale green and black. The wings of all have the tips clouded. It feeds on the undersides of the leaves of the thimbleberry in California.

The myrtle aphis, *Rhopalosiphoninus latysiphon* (Davidson) (*Amphorophora*), is a green species with large antennal tubercles and curiously swollen cornicles which are very slender at the bases and tips and unusually large in the middle. It occurs on the tender tips of chrysanthemum, cowslip, myrtle (*Vinca*), Shasta daisy, morning glory, and potato in the San Francisco Bay region, California.

The pea aphis, *Illinoia pisi* (Kaltenbach),[1] is a large, immaculate, green species which is often a serious pest to various legumes throughout the

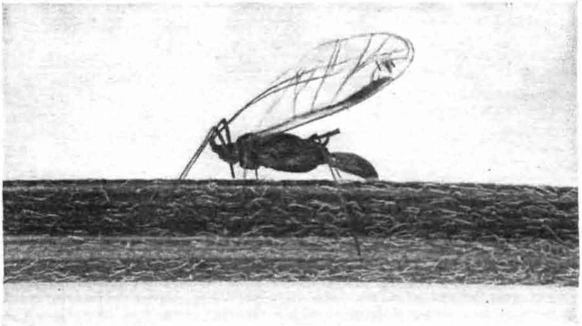

FIG. 139.—The alfalfa aphis, *Illinoia creeli* (Davis). Parthenogenetic female giving birth to young. (Photo furnished by S. B. Doten.)

entire country. Eggs are reported in the Northern States, while in the milder regions breeding continues throughout the winter. It is particularly injurious to peas and causes heavy losses every year in many States, especially where canning peas are grown. It is also destructive to alfalfa, clovers, vetch, melilotus, sweet peas, lentil, and many other cultivated and wild legumes. The fungus, *Entomophthora aphidis* (Hoffm.), is quite effective in destroying the aphis during the winter and spring in Washington, Oregon, and California. Thorough spraying and dusting give control under favorable conditions (Fig. 140).

Illinoia liriodendri (Monell) is green and infests the tulip tree in California and Eastern States. *I. macrosiphum* Wilson is whitish yellow with very long cornicles and

[1] J. J. Davis, Bul. 276, *Prof. Paper*, U. S. Dept. Agr. 1915.
In Europe the pea aphis is placed in the Genus *Acyrthosiphon*. *Rev. Appld. Ent. Ser.*, A, 8. 1920, p. 47.

infests shad bush in Oregon. *I. osmaroniæ* Wilson is a large, pale green species often abundant on oso berry in Oregon. **The alfalfa aphis,** *I. creeli* (Davis) (Fig. 139), resembles the pea aphis and infests alfalfa in Washington, Nevada, and Utah. **The pumpkin aphis,** *I. cucurbitæ* (Thos.), is a green species on pumpkins, melons, squashes, and gourds, in California and probably many other Western States. **The elderberry aphis,** *I. stanleyi* (Wilson), is a beautiful, large, pale yellow or yellow and black species often abundant on the undersides of the older leaves of elderberry in British Columbia, Washington, Oregon, and California.

The lupine aphis, *Macrosiphum albifrons* Essig, is a large, green species entirely covered with white, powdery wax. The legs, antennæ, and cornicles are very long, *the latter being sub-cylindrical, a characteristic of the genus. It seriously infests the* tips of various annual and perennial lupines in California during the spring and early summer. **The ambrosia aphis,** *M. ambrosiæ* (Thomas), is a large, dark brown species

FIG. 140.—Applying nicodust to peas for the control of the pea aphis, *Illinoia pisi* (Kalt.). A long canvas, allowed to drag behind the power duster, confines the dust and greatly *increases the efficiency of the outfit. (Photo furnished by the Bean Spray Pump Company.)*

which infests ragweed, wild lettuce, poverty weed, cone flower, and wild sunflower in California and Colorado. **The artemisia aphis,** *M. artemisiæ* (Fonsc.) (*M. frigidæ* Oestlund), is a metallic dark green or blackish species often present in dense colonies on the shoots of artemisia in British Columbia, Washington, Oregon, California, and Colorado. **The California willow aphis,** *M. californicum* (Clarke), is a large, very slender, pale green *species often very abundant on the tender tips of willows in early spring* throughout California. **The grass aphis,** *M. dirhodum* (Walker), is a large, green or yellowish species which winters on roses and passes the summer on grains and grasses in Colorado. It also occurs in California and Utah. **The grain aphis,** *M. granarium* (Kirby), is a very common, green and black species which overwinters on roses or on grains and grasses, and which often proves a serious pest to wild grasses, cat-tail, and hay and grain crops, corn, and sorghum, throughout the country. It occurs in practically every Western State and is preyed upon by natural enemies much the same as those listed under the pea aphis, and many others as published by W. J. Phillips[1] for the Eastern States. **The wormwood aphis,** *M. ludovicianæ* (Oestlund), is a large green species covered with a thin, white pulverulence, which infests wormwood or mugwort and artemisia from British Columbia to California and Colorado. **The rhododendron aphis,** *M. rhododendri* Wilson, has pale green or pinkish forms which infest the rhodo-

[1] *Jour. Agr. Research*, 7, 1916, p. 463.

dendron in Oregon. **The rose aphis,** *M. rosæ* (Linn.)[1] (Fig. 130, K, L), is the common large species infesting the buds and terminal shoots of wild and cultivated roses throughout the country. There are green and pinkish apterous and winged forms with black cornicles, antennæ, and other markings. It is heavily preyed upon by the common predators and parasites. **The cone flower aphis,** *M. rudbeckiæ* Fitch, is a large, shining, red or dark brown species in compact colonies on cone flower, chrysanthemum, lettuce, baccharis, goldenrod, ragweed, sunflower, fullers' teasel, and related plants in British Columbia, Oregon, California, New Mexico, and Colorado. **The goldenrod aphis,** *M. solidaginis* (Fabr.), is bright red and infests asters and goldenrod in Oregon and Colorado. **The potato aphis,** *M. solanifolii* (Ashmead) [*M. citrifolii* (Ashm.)],[2] is one of the commonest members of the genus occurring on a wide variety of plants throughout the United States and Canada. There are green and pink forms in nearly every colony. The host plants are apple, asparagus, aster, atriplex, bean, buckwheat, cineraria, citrus, clover, corn, eggplant, fairybells, fuchsia, gladiolus, ground cherry, iris, lambsquarters, nightshade, oxalis, peas, pigweed, potato, potato vine, rose, shepherd's purse, sow thistle, turnip, white-stem filaree, and wild lettuce. The winter in the colder regions is passed on roses and the spring forms migrate to other plants, while in warmer sections the winters and summers are spent on similar plants, the egg stage being omitted altogether.

The chrysanthemum aphis, *Macrosiphoniella sanborni* (Gillette) (*Macrosiphum*), is a large, shiny, very dark brown or black species with cornicles scarcely longer than the cauda, and smallest at the tips. It infest chrysanthemum in Oregon, California, and Colorado.

The columbine aphis, *Myzus*[3] *aquilegiæ* Essig, is a small, green and pinkish species often with a large, dark blotch on the dorsum of the abdomen. It infests wild and cultivated columbines in California.

The artichoke aphis, *Myzus braggi* Gillette, is pale yellow and green with darker green markings. It is often abundant on the undersides of the leaves of the globe artichoke and is a serious pest wherever this plant is grown commercially, particularly in California and Louisiana.[4] Prof. C. P. Gillette[5] reports it on Canadian and other thistles as the summer, and *Elæagnus*, Russian olive, and *Shepherdia* as the winter hosts. T. H. Jones also reports the yellow thistle as a summer host in Louisiana.

The black cherry aphis, *Myzus cerasi* (Fabricius) (Fig. 141), is a large, shiny, metallic black species which becomes very abundant on sweet cherry trees in the early spring, causing curling and distortion of the leaves. The cherry is the winter host on which the eggs are laid and the early spring broods subsist. In midsummer the winged forms migrate to various alternate hosts which according to W. A. Ross[6] are lepidium, and perhaps other cruciferous plants. Prof. C. P. Gillette[7] records only the sour cherry as the winter host in Colorado and water cress as the summer host. The leaves of the sour cherry are not curled and the aphis may occur on it throughout the year. The species is reported in British Columbia, Washington, Oregon, California, Idaho, Nevada, Utah, and Colorado. Along the Pacific Coast the sweet cherry is the preferred winter host but the summer hosts have not been observed, although it has long been well known that the aphis disappears about midsummer. Control measures in the form of dusts or

[1] H. M. Russell, Bul. 90, Bur. Ent. U. S. Dept. Agr. 1914.

[2] E. M. Patch, *Pink and Green Aphid of Potato.* Bul. 242, Maine Agr. Exp. Sta. 1915.

[3] Members of the genus *Myzus* have prominent antennal tubercles which are strongly gibbous and project inwardly in the apterous forms. The cornicles are long and subcylindrical and the cauda short and conical.

[4] Thos. H. Jones, Bul. 703, U. S. Dept. Agr. 1918, p. 1.

[5] *Jour. Econ. Ent.*, 8, 1915, pp. 102, 375.

[6] *Can. Ent.*, 49, 1917, p. 434.

[7] *Can. Ent.*, 50, 1918, p. 241.

sprays should be applied when the leaf buds are opening in the spring, to kill the young stem-mothers before they are protected by the curled leaves.

The lily aphis, *Myzus circumflexum* (Buckton), is a very pretty, pale or bright yellow and black species infesting the terminal shoots, buds, and leaves of lilies in greenhouses throughout the country. In California it occurs outside on asparagus, buckeye, California laurel, ceanothus, chickweed, foxglove, meadow foxtail, fuchsia, gladiolus, hedge mustard, lilies, myrtle,

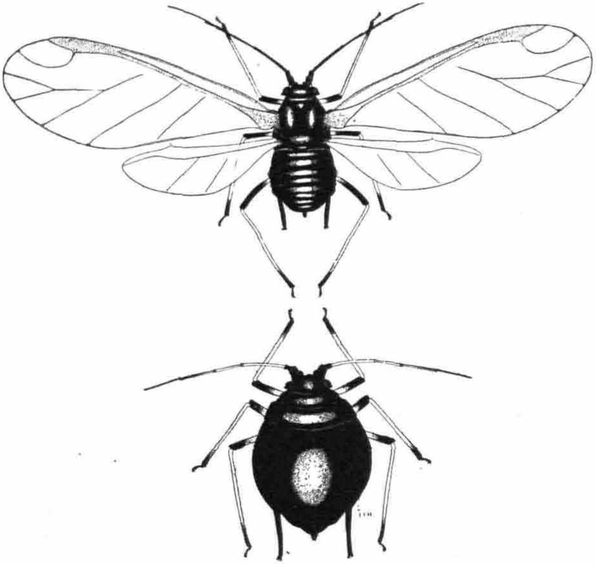

FIG. 141.—The black cherry aphis, *Myzus cerasi* (Fabr.).

nightshade, plantain, pentstemon, senecio, snowberry, stachys, violet, and wallflower. *M. vincæ* Gillette is similar, if not identical, and is recorded on asparagus, myrtle, columbine, dock, and lily in Colorado and California.

The strawberry aphis, *Myzus fragæfolii* Cockerell, is a very small, pale yellow or almost white species occurring in great numbers on the tender shoots and undersides of the leaves of wild and cultivated strawberries throughout the year in Oregon, California and Arizona. The removal and destruction of all the foliage in the winter and the liberal application of nicodust to the undersides of the leaves in summer afford satisfactory control measures.

The tomato aphis, *Myzus lycopersici* (Clarke), is pale lemon yellow, some of the young forms being pink, and the winged forms yellow and black. It was reported from tomato in California by W. T. Clarke [1] in 1903, but has probably been generally confused with the green peach aphis which it greatly resembles. J. J. Davis [2] records it on celery, tomato, and wheat in Oregon, Idaho, and Montana.

The green peach aphis, *Myzus persicæ* (Sulzer) [3] [*Rhopalosiphum persicæ* (Sulzer)] (Figs. 142, 143), is one of the commonest aphis throughout North America. The immature forms are yellow, pinkish, or pale green; the mature, apterous forms are pale or bright green; the winged forms are pale or bright green and black, with a characteristic large, dusky blotch on the dorsum of the abdomen. It probably occurs in every Western State and is a very general feeder having been observed on amsinckia, apricot,

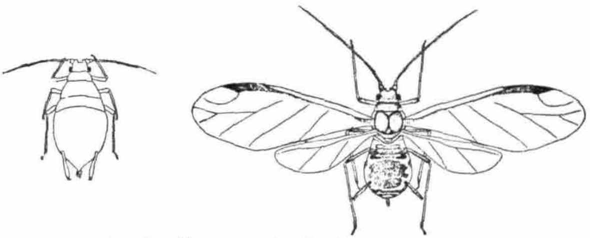

FIG. 142.—The green peach aphis, *Myzus persicæ* (Sulzer).

cabbage, carnation, cauliflower, celery, cherry, chrysanthemum, citron, cucumber, dock, eggplant, grapefruit, groundsel, hound's tongue, English ivy, lemon, lettuce, false mallow, malva, mustard, nettle, orange, peach, pepper, pigweed, plum, potato, radish, rhubarb, shepherd's purse, snapdragon, sow thistle, spinach, turnip, tomato, and walnut. In the Northern States it winters on peach, plum, cherry, and prune, and migrates to the summer hosts. In the milder sections it is abundant throughout the year. It transmits mosaic disease of sugar beets in the west and is probably responsible for carrying other plant diseases as well. It is subject to a great many predaceous enemies. The fungus, *Entomophthora aphidis* (Hoffm.), kills great numbers of the overwintering forms in California. In 1923 whole fields of spinach in the Santa Clara Valley were rid of the aphis by the work of this parasitic fungus. (Fig. 143). It also quite readily succumbs to dusting with nicodust or calcium cyanide. *M. varians* Davidson also somewhat resembles the green peach aphis but is paler in color. It often causes the leaves of peach to turn red and curl much like the work of the curl leaf disease. It also infests wild and cultivated clematis in the San Francisco Bay region, California.

[1] *Can. Ent.*, 35, 1903, p. 253.
[2] *Can. Ent.*, 46, 1914, p. 123.
[3] C. P. Gillette, *Jour. Econ. Ent.*, 8, 1915, p. 102.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 98.

The currant aphis, *Myzus ribis* (Linn.), varies from pale yellowish green to pinkish and dark green, the winged forms with black markings. It infests red, black, and wild currants causing the leaves to turn red and curl into pseudogalls in the spring of the year. Gooseberries, deutzia, lippia, snowball, and sow thistle are occasionally infested. C. P. Gillette[1] records the black currant, red currant, and wild currant as winter hosts, and stachys and motherwort (*Leonurus*), as summer hosts in Colorado. It is recorded in British Columbia, Washington, Oregon, Montana, Nevada, Utah, and Colorado in the west. *M. ribifolii* Davidson and *M.*

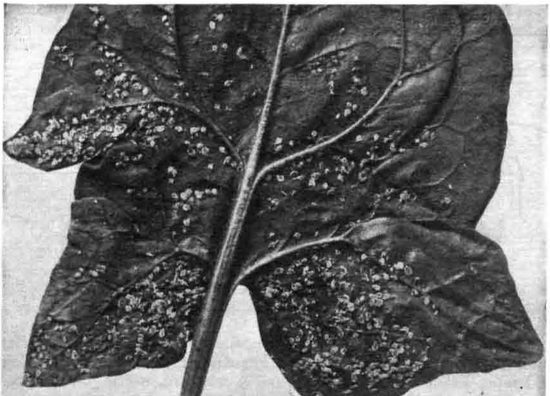

FIG. 143.—The green peach aphis, *Myzus persicæ* (Sulzer), on spinach and killed by the fungus, *Entomophthora aphidis* (Hoffm.), which covers the bodies.

houghtonensis (Troop) are reported from wild currant in California. *M. rhamni* (Fonsc.) is a green and pink species often abundant on the terminal shoots and leaves of the wild coffee berry and cascara sagrada in Oregon and California.

The hop aphis, *Phorodon humuli* (Schrank)[2] (Fig. 144), is pale yellowish green in the apterous, and green and black in the winged forms. The large antennal tubercles of the apterous forms and the long, somewhat curved cylindrical cornicles easily distinguish the species. It winters chiefly in the egg stage on plum and prune and rarely on alder, apple, peach, and cherry. The spring forms may be present in sufficient numbers to entirely cover the under-surfaces of the leaves. As soon as winged forms appear in early summer they migrate to the hops which appear to be the chief

[1] C. P. Gillette, *Jour. Econ. Ent.*, 10, 1917, p. 338.
[2] W. T. Clarke, *The Hop Aphis*. Bul. 160, Cal. Agr. Exp. Sta. 1904.
W. B. Parker, *The Hop Aphis*. Bul. 111, Bur. Ent., U. S. Dept. Agr. 1913.

summer host, although the writer has also taken it on cultivated sunflower throughout the summer. In California it may pass the entire summer on

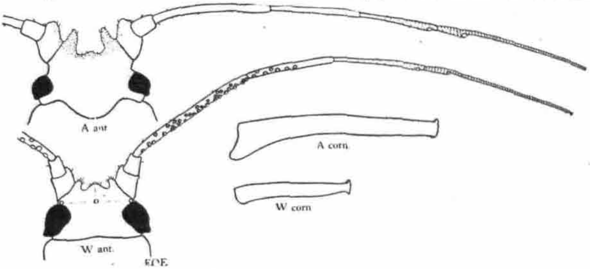

Fig. 144.—The hop aphis, *Phorodon humuli* (Schrank). A ant, head and antenna of apterous form; W ant, head and antenna of the winged form; o, ocelli; A corn, cornicle of the apterous form; W corn, cornicle of the winged form.

plums and prunes and it may also winter in the living form in the crown of the male hop plants in the fields. The transfer from the alternate host plants to hops is the rule however.

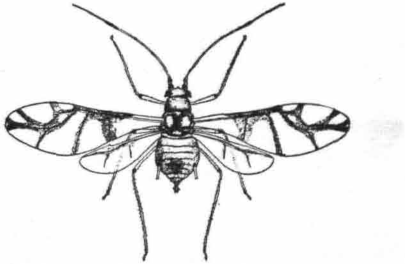

Fig. 145.—The fern aphis, *Idiopterus nephrolepidis* Davis. Winged form.

The red violet aphis, *Neotoxoptera violæ* (Pergande) (*Rhopalosiphum*),[1] is a beautiful, wine red species with clouded wing veins and swollen cornicles. It infests the tender shoots, buds, and leaves of the wild and cultivated violet throughout California and occurs in greenhouses in various parts of the United States and Canada.

The fern aphis, *Idiopterus nephrolepidis* Davis[2] (Fig. 145), is a small, pitch black species with whitish legs and conspicuous black clouded areas in the wings. It is often taken in greenhouses and residences throughout the country on ferns and occasionally

[1] F. H. Chittenden, Bul. 27 n. s. Div. Ent. U. S. Dept. Agr. 1901, p. 42.
E. O. Essig, *P. C. Jour. Ent.*, 1, 1909, p. 4.

[2] J. J. Davis, *Ann. Ent. Soc. Am.*, 2, 1909, p. 198. This species was originally wrongly spelled *nephrelepidis*.
E. O. Essig, *P. C. Jour. Ent.*, 3, 1911, p. 538.

taken in greenhouses and in the open in California. **The banana aphis,** *Pentalonia nigronervosa* Coquerel,[1] is reddish brown or almost black with dark, clouded wings somewhat resembling the fern aphis, but with an altogether unique wing venation. It is a tropical species often introduced into this country on bananas. A. F. Swain also reports it on geranium.

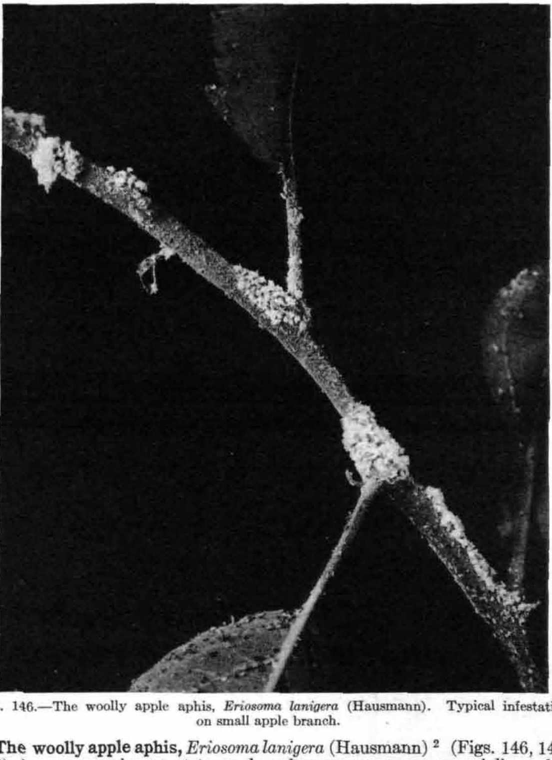

FIG. 146.—The woolly apple aphis, *Eriosoma lanigera* (Hausmann). Typical infestation on small apple branch.

The woolly apple aphis, *Eriosoma lanigera* (Hausmann)[2] (Figs. 146, 147, 148), is a very serious pest to apples wherever grown commercially and is

[1] H. F. Wilson, *Jour. Econ. Ent.*, 2, 1909, p. 346.
[2] A. C. Baker, "The Woolly Apple Aphis." *Rept.* 101, U. S. Dept. Agr. 1915. In some parts of Europe this aphis is commonly known as the American Blight.

a well known native American insect, characterized by the reddish body which is entirely hidden with long, white, wool-like wax. The cornicles are little more than elevated rings; the antennæ vary from 5-segmented in the stem-mothers to 6-segmented in the winged forms. The sensoria in the latter are numerous and annular in form. The wings have a single-branched media vein. All forms are bark feeders living on the limbs and roots of the trees and causing large, warty excrescences which often seriously interfere with the growth of the trees, and which at times cause the death of young trees. The life history is somewhat complicated in the colder regions where the winter is spent chiefly on elms and where in the spring curled leaves and leaf rosettes are formed in which the first generations are reared. Winged forms migrate to apple and related trees for the summer. Such a condition is noted in the Northeastern States and also in Colorado.[1] In most of the Western States, however, the entire life cycle is apparently spent on the tops and roots of the apple. The pear, hawthorn, and mountain ash are also occasionally infested. Control measures consist in the application of light oil sprays during the winter. Much success in killing the root forms has been obtained by using paradichlorobenzene as a soil fumigant during the summer and fall in California, without any apparent injury to either young or old apple trees. From ¾ to 1 ounce of material was used to a tree. A diluted solution of carbon disulfid, 1 ounce to 4 gallons of water, poured in a basin at the bases of the trees has also given good results. From 2 to 4 gallons of the mixture are required, depending upon the size of the tree. **The elm gall aphis,** *E. americana* (Riley), also produces curled leaves and rosettes on the elm and migrates to the apple in the summer. It is common in the east, but is recorded from the west only in British Columbia, Montana, Colorado, California, and New Mexico. *E. cratægi* (Oestlund) is close to, if not identical, with the woolly apple aphis. It is commonly taken on English hawthorn and is reported from Colorado in the west. *E. rileyi* (Thomas) causes knotty growths on the trunks, limbs, and twigs of elm trees confining its attacks to the bark. It is recorded from Oregon, Nevada, and Colorado in our region. **The European elm leaf-curl aphis,** *E. ulmi* (Linn.), winters on elm causing a curling of the leaves in the spring and migrates to currants in the summer. It is

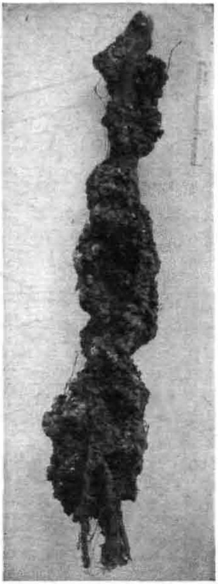

FIG. 147.—Galls on the roots of a young apple tree produced by the woolly apple aphis, *Eriosoma lanigera* (Hausm.).

[1] A. C. Maxson, *Ent. News*, 26, 1915, p. 367.

common in the east and known in British Columbia, Oregon, and Colorado in the west.

The pear root aphis, *Eriosoma languinosa* (Hartig) (*E. pyri* Fitch, *E. pyricola* Baker and Davidson),[1] is a dull green or bluish, slightly flocculent species which winters preferably on the European elms, but can live on the

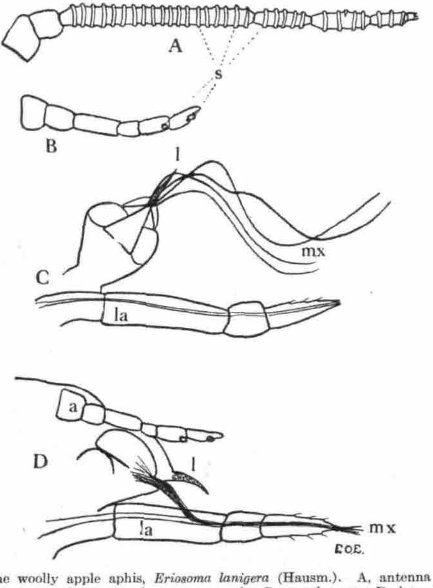

FIG. 148.—The woolly apple aphis, *Eriosoma lanigera* (Hausm.). A, antenna of winged form; B, antenna of apterous form; s, sensoria; C, mouth parts; D, lateral aspect of head; a, antenna; l, labrum; la, labium; mx, maxillæ.

American elm, producing in the spring large bonnet- or cockscomb-like, reddish and yellowish green galls on the leaves (Fig. 149). It migrates to the pear trees during the summer, attacking chiefly the roots of the Bartlett, but is known also to feed on other commercial varieties, and sparingly

[1] Geo. P. Weldon, "The Woolly Aphis as a Pear Pest." *Mthly. Bul.*, Cal. Hort. Com. 4, 1915, p. 441.
A. C. Baker, "Identity of *Eriosoma pyri*." *Jour. Agr. Research*, 5, 1916, p. 1115.
A. C. Baker and W. M. Davidson, "The Woolly Pear Aphis." *Jour. Agr. Research*, 6, 1916, p. 351; 10, 1917, p. 65.
W. M. Davidson, *Mthly. Bul.*, Cal. Hort. Com. 6, 1917, p. 390.

on Japanese pear and on quince. Wingless agamic females remain on the pear roots throughout the entire year independent of the migrants which fly to and from the elm trees. It is a European species established in the west in Washington, Oregon, and California since about 1892 and is a serious pest to pears grafted on the European pear rootstocks, and is particularly serious in heavy adobe soils. Young trees up to five years of age are most susceptible to attack and may be killed outright or permanently stunted. Control measures consist in setting out young trees grafted on Japanese pear or on quince rootstocks; or the treatment of infested trees with paradichlorobenzene which has given excellent results in California, without any apparent injury to young trees.

FIG. 149.—Cockscomb or bonnet gall produced on elm leaves in the spring by the stem mothers of the pear root aphis, *Eriosoma languinosa* (Hartig).

The elm and grass aphis, *Colopha ulmicola* (Fitch) (*Byrsocrypta*) and *Tetraneura graminis* Monell, winter on elm, forming leaf galls in the spring, and migrate to the roots of various grasses in the summer. The sex forms are wingless and without mouth parts. They occur in many parts of the country and the west.

The poplar gall aphis belong to a number of related genera, winter over on poplar and cottonwood trees producing leaf or stem galls in the spring, and migrate to the roots of succulent annual and perennial plants during the summer. The migrants returning to the trees in the late fall often appear in large swarms. *Cornaphis populi* Gillette has well developed cornicles; 5- to 6-jointed antennæ; simple media veins in the fore wings; sexes, small, apterous, and lacking mouth parts. All forms live together in a crescent-shaped pseudogall on the edge of the leaves of the long-leaved poplar in Wyoming. *Mordwilkoja vagabunda* (*Byrsocrypta*) has rudimentary ring-like

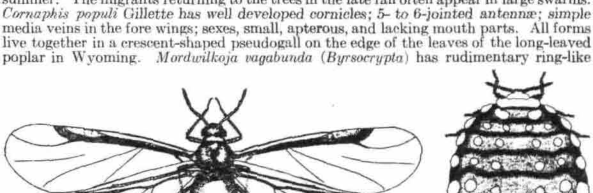

FIG. 150.—The poplar stem gall aphis, *Pemphigus populicaulis* Fitch. Winged migrant and stem mother removed from the galls.

cornicles, 4- to 5-segmented antennæ, simple media in fore wings. It winters on poplars, cottonwood, and aspen, all forms living together in imperfectly formed irregular rosette-like galls on the leaves. Winged forms migrate in summer to unknown hosts, although living forms have been taken in galls at Lake Tahoe, California, as late as August. It occurs in Colorado, Nevada, and California in the west. **The poplar stem gall aphis,** *Pemphigus populicaulis* Fitch [1] (*Fig. 150*), forms somewhat globular galls with long,

[1] E. O. Essig, *P. C. Jour. Ent.*, 4, 1912, p. 708.

oblique openings on the petioles of the bases of the leaves of cottonwood and poplars. The stem-mothers are yellow or greenish, covered with small, cottony patches arranged in distinct rows. The winged forms are small, dark, and partially covered with long, white, cottony wax. The summer hosts are unknown. The species is widely distributed and is quite common in California. The larvæ of the syrphid fly, *Heringia californica* (Davidson) (*Pipiza*)[1] feeds on the lice in the galls. *P. populitransversus* Riley (Fig. 151) forms rather regular galls with transverse openings, on the petioles of cottonwoods and poplars. According to Jones and Gillette[2] the summer hosts are chiefly the roots of cruciferous plants, including Brussels sprouts, cabbage, rape, turnip, water cress,

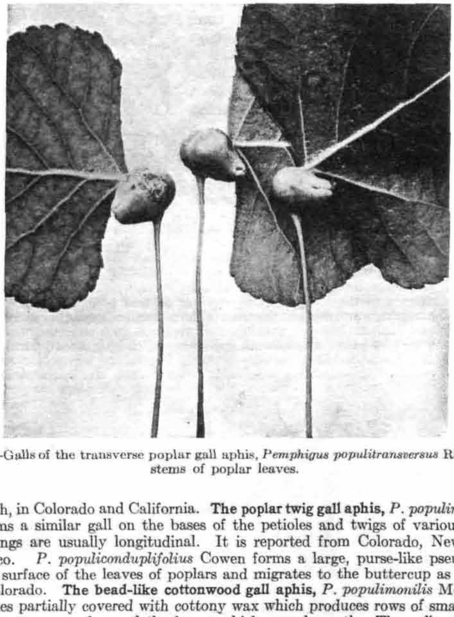

FIG. 151.—Galls of the transverse poplar gall aphis, *Pemphigus populitransversus* Riley, on the stems of poplar leaves.

and so forth, in Colorado and California. **The poplar twig gall aphis,** *P. populiramulorum* Riley, forms a similar gall on the bases of the petioles and twigs of various poplars. The openings are usually longitudinal. It is reported from Colorado, New Mexico, and Mexico. *P. populiconduplifolius* Cowen forms a large, purse-like pseudogall on the upper surface of the leaves of poplars and migrates to the buttercup as a summer host in Colorado. **The bead-like cottonwood gall aphis,** *P. populimonilis* Monell,[3] is a large species partially covered with cottony wax which produces rows of small pseudogalls on the upper surfaces of the leaves which open beneath. The galls are usually arranged in rows around the margins or along the midrib of the leaves of cottonwood and poplars in Colorado and California.

[1] W. M. Davidson, *Ent. News*, 28, 1917, p. 414.
[2] T. H. Jones and C. P. Gillette, *Jour. Agr. Research*, 14, 1918, p. 577.
[3] C. P. Gillette, *Ann. Ent. Soc. Am.*, 6, 1913, p. 485.
E. O. Essig, *P. C. Jour. Ent.*, 4, 1912, p. 704.

The beet root aphis, *Pemphigus betæ* Doane [1] (Fig. 152), as it appears on the roots of beets, dock, grasses, and weeds, is a small, wingless, elongated, oval, white or yellowish species with a tuft of white or cottony material at the posterior end of the body. The winged forms are mostly black with thin, white, waxy covering. This species winters on poplars and feeds on

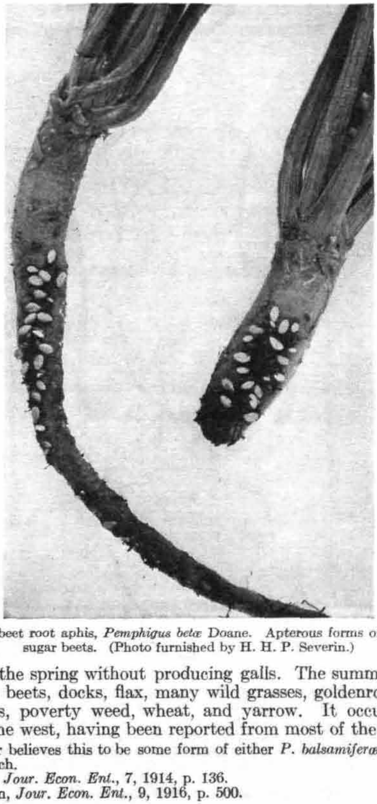

FIG. 152.—The beet root aphis, *Pemphigus betæ* Doane. Apterous forms on roots of young sugar beets. (Photo furnished by H. H. P. Severin.)

the leaves in the spring without producing galls. The summer is spent on alfalfa, aster, beets, docks, flax, many wild grasses, goldenrod, knotweed, lambsquarters, poverty weed, wheat, and yarrow. It occurs generally throughout the west, having been reported from most of the States.

[1] A. C. Baker believes this to be some form of either *P. balsamiferæ* Williams or *P. populivenæ* Fitch.
J. R. Parker, *Jour. Econ. Ent.*, 7, 1914, p. 136.
A. C. Maxson, *Jour. Econ. Ent.*, 9, 1916, p. 500.

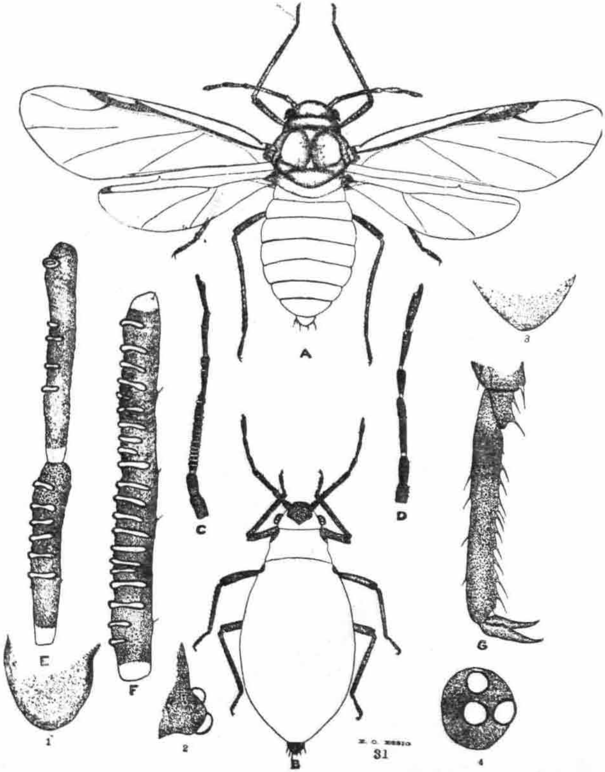

FIG 153.—The woolly buttercup aphis, *Prociphilus californicus* (Davidson). A, winged migrant; B, apterous form with cottony material removed; C, antenna of winged form; D, antenna of apterous female; E, and F, joints 3, 4, and 5 of the antenna of the winged form showing elongated sensoria; G, tarsus; 1, cauda; 2, lateral view of compound eye; 3, front view of compound eye of apterous form; 4, cauda of winged form.

A closely related genus, *Prociphilus*, has no cornicles, but a single branched media vein, 5- to 6-segmented antennæ; and small, apterous and beakless sexes. They are usually quite large, the stem-mothers pale and robust and the alate forms dark; all are covered with some white, cottony, waxy material. Pseudogalls in which all forms live together are usually formed on the overwintering hosts. Summer hosts are not known for all species. *P. alnifoliæ* (Williams) (*Pemphigus*) infests Christmas berry in California and shad berry in Colorado. *P. californicus* (Davidson) (Fig. 153) is a California species wintering on Oregon ash and migrating to the buttercup as a sum-

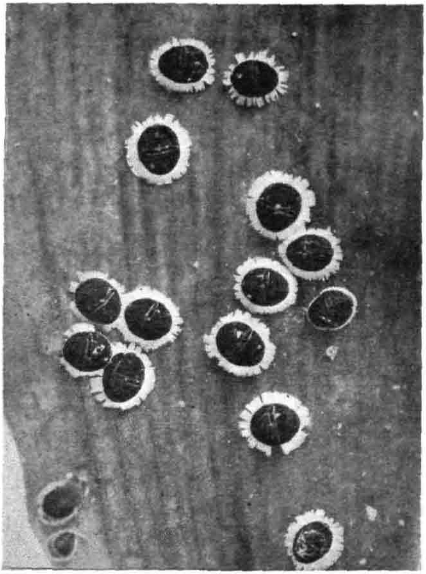

FIG. 154.—The lantana aphis, *Cerataphis lantaniæ* (Boisd.). Young and mature apterous females on an orchid leaf. In this stage it greatly resembles the immature forms of certain aleyrodids or white flies.

mer host. *P. corrugatans* (Sirrine) winters on hawthorns and shadberry as far west as Colorado. *P. fraxinifolii* (Riley) winters on ash in Oregon and Colorado. *P. venafuscus* Patch is a very large species often abundant on ash but also reported from buckeye and Douglas fir in Oregon and California. It is a common eastern species. *P. fraxini-dipetelæ* Essig is probably a synonym of the latter.

The poplar aphis *Asiphum pseudobyrsa* (Walsh) (*Schizoneura populi* Gillette),[1] is a very small, pale yellow species with white, waxy covering which lives in the cracks and crevices of the bark of the trunks and limbs and on the leaves of cottonwood and poplar trees in Colorado.

[1] C. P. Gillette, *Ent. News*, 25, 1914, p. 269.

The grass root aphis of the genus *Forda* [1] have no cornicles and 5-segmented antennæ. The apterous females are usually oval in form, and the eyes are composed of three facets each. The winged forms are dark, with simple media vein. They live on the roots of wild grasses and are usually attended by ants. **The grain root aphis,** *F. formicaria* Heyden (*F. occidentalis* Hart), is pale whitish or grayish green and feeds on the roots of grasses, corn, wheat, and shepherd's purse. It is reported in Montana, Colorado, and California. *F. olivacea* Rohwer is pale greenish yellow in the apterous and dark olive green in the winged form. It is often abundant and does some damage every year to grasses and grain in Colorado. It infests wild grasses, barley, oats, timothy, wheat, and wild rye.

The solanum root aphis, *Geoica radicicola* (Essig) (*Pemphigus, Trifidaphis*), is also a root-infesting species. The apterous forms are small, nearly globular, whitish, with no cornicles, 5-segmented antennæ and eyes of three facets each. The winged forms are black and white, without cornicles, with 6-segmented antennæ, large, oval sensoria, and simple media vein in the fore wings. This aphis is widely distributed in sandy soils of California and infests the roots of asters, beans, dahlias, nightshade, pigweed, and potato. It was recently taken in Ohio by C. R. Cutright on roots of beans.

The minute live oak aphis, *Hamamelistes agrifoliæ* Ferris, is a very small, oval, aleyrodiform, pale yellow species, 0.6 mm. long. There are 4-segmented antennæ and no cornicles in the apterous forms. It infests the young twigs of the coast live oak in Southern and Central California.

The lantana aphis, *Cerataphis lantaniæ* (Boisduval) (*Coccus*) (Fig. 154), has a very interesting apterous form which is often mistaken for a coccid or an aleyrodid because of the dark, convex, disc-like body with a wide, white, lateral, wax fringe when mature. The antennæ are 4-segmented and the cornicles ring-like. The winged forms, however, are fairly normal, dull brown or blackish in color, with 5-segmented antennæ, knobbed cauda, and one-branched media vein of the fore wings. This species is frequently taken in greenhouses on orchids in California, but also infests coconut, ferns, palms, and vanilla.

COCCIDÆ [2] Coccids, Mealybugs, Scales, Scale Insects.

These are the most indefinite members of the order *Homoptera* and the ones most likely to be confusing to the student. They are small, active or

[1] C. P. Gillette, *Ent. News*, 29, 1918, p. 281.

[2] W. M. Maskell, "New Zealand *Coccidæ*." *Trans. N. Z. Inst.*, 11, 1879, p. 187; 16, 1884, p. 120; 17, 1885, p. 20; 19, 1887, p. 45; 22, 1890, p. 133; 23, 1891, p. 1; 24, 1892, p. 1; 25, 1893, p. 201; 26, 1894, p. 65; 27, 1895, pp. 1, 36; 28, 1896, p. 293; 30, 1898, p. 23.

J. H. Comstock, "Reports on Scale Insects." *Rept.* U. S. Dept. Agr. 1880, 1881, pp. 276, 372; 1881, 1882, p. 209. "Second Rept. on Scale Insects." *Rept.* Cornell Univ. Agr. Exp. Sta. 2, 1883, p. 47. *Report on Scale Insects.* Bul. Cornell Agr. Exp. Sta. 372, 1916, p. 423. (Reprint of Preceding Reports.)

E. E. Green, *The Coccidæ of Ceylon.* London, 1, 1896; II, 1899; III, 1904; IV, 1909.

R. A. Cooley, *The Coccid Genera Chionaspis and Hemichionaspis.* Hatch, Exp. Sta. Mass. Agr. Coll. Spec. Bul. 1899.

S. I. Kuwana, "New and Little Known California *Coccidæ*." *Proc. Calif. Acad. Sci., Zoöl.* (3), 2, 1901, p. 401; 3, 1902, p. 43. Also Contrib. Biol. Hopkins Seaside Lab. L. Stanford Jr. Univ. Nos. 25, 27.

R. Newstead, "Mon. of the *Coccidæ* of the British Isles." *Ray Society*, 1, 1901; 2, 1903.

M. E. Fernald, *Cat. of Coccidæ of the World.* Carpenter & Morehouse, Amherst, Mass., 1903.

J. G. Sanders, "*Coccidæ* of Ohio." *Spec. Paper* 8, *Proc. Ohio State Acad. Sci.*, 4, pt. 2, 1903, p. 27. *Cat. Recently Described Coccidæ.* Bul. Bur. Ent., U. S. Dept. Agr. 1, Tech. Ser. 12, pt. I, 1906; II, 16, pt. 1909, p. 33. "Identify and Synonymy of our Soft Scale Insects." *Jour. Econ. Ent.*, 2, 1909, p. 428.

T. D. A. Cockerell, *Tables for the Identification of Rocky Mt. Coccids.* Univ. Colo. Studies, 2, 1905, p. 189.

L. Lindinger. *Die Schildläuse.* Stüttgart 1912.

E. R. Sasscer, *Cat. Recently Described Coccidæ* III, Bul. Bur. Ent. U. S. Dept. Agr.

stationary, naked, with a hard epidermis or covered with a thin or thick, waxy secretion, or with a definite round, oval or elongated shell. The antennæ are well developed or absent, the rostrum appears to arise between the front legs, and the tarsi are one-jointed, terminating in a single claw. A great many of the scale insects are able to produce, by means of special glands, a scale or shell-like covering from which the common name is derived, while some have the epidermis hardened into a thick, tough, chitinous wall, and still others are protected by a thin coat or an abundance of a whitish, powdery or cotton-like wax. The different armaments and coverings serve admirably to protect the insects, not only from natural enemies and climate, but also from sprays and fumigation to a marked degree. The young are born alive or hatch from eggs. All are motile and constitute the migrating or wandering stage of the species, but after the first molt they become stationary in most of the armored species. The females are the sex most commonly known and are of many shapes. Some are motile throughout their existence and move quite freely, but slowly. The males early pass through a quiescent metamorphosis in a cocoon or under a scale or thin shell, and emerge as delicate, apterous but more often two-winged insects, with usually two conspicuous, long, white anal filaments or tails, when the females are about one-fourth or one-third mature. At this time and later, mating takes place and the males disappear. In some species like the mealybugs the males may be present in great swarms, hovering in the air about the plants infested by the females, on dull days or more particularly from near sunset to dusk on warm, bright days. The males have abortive mouth parts and take no food. The females are entirely responsible for the injury to plants. Feeding consists in extracting the plant juices and causing the general depletion of the host. Some species are believed to exude a toxic substance which is injurious to plants.

Scale insects are usually present in enormous numbers and are among the most destructive insects, not only to fruit trees but also to forest and shade trees, ornamental trees and shrubs, garden plants and, in fact, to all types of plant life. Very few species are restricted in their feeding

Tech. Ser. 16, pt. 4, 1911, p. 61; IV, 16, pt. 6, 1912, p. 83; V, *Proc. Ent. Soc. Wash.*, 17, 1915, p. 25. *An Index to Catalogues of Recently Described Coccidæ*, Bul. Bur. Ent., U. S. Dept. Agr. Tech. Ser. 16, pt. 7, 1913, p. 99.

E. O. Essig, "Notes on Calif. *Coccidæ.*" *P. C. Jour. Ent.*, I–VI, 1, 1909, pp. 11, 92; 2, p. 209, 1910; 3, 1911, pp. 404, 469; 6, 1914, p. 76. *Monthly Bul.*, Cal. Comm. Hort. 3, 1914, p. 97.

H. F. Dietz and H. Morrison, "The *Coccidæ* or Scale Insects of Indiana." *Rept. Ind. State Entom.*, 1916, p. 195.

L. Florence, "Pacific Coast Species of *Xylococcus.*" *Ann. Ent. Soc. Am.*, 10, 1917, p. 147.

G. F. Ferris, *The California Species of Mealy Bugs.* L. Stanford Jr. Univ. Pub. Univ. Ser. 1918. *A Contrib. to the Knowledge of Coccidæ of Southwestern U. S.* Leland Stanford Jr. Univ. Pub. Univ. Ser. 1919. "Scale Insects of the Santa Cruz Peninsula." *Stanford Univ. Pub. Univ. Ser. Biol. Sci.*, 1, No. 1, 1920. "Report upon a Coll. of *Coccidæ* from Lower Calif." *Stanford Univ. Pub. Univ. Ser. Biol. Sci.*, 1, No. 2, 1921. "Notes on *Coccidæ.*" *Can. Ent.*, 50, 1918, pp. 221, 323; 51, 1919, pp. 108, 249; 52, 1920, pp. 29, 61; 53, 1921, pp. 57, 91.

R. H. Pettit and E. McDaniel. *The Lecania of Mich.* Tech. Bul. 48, Mich. Agr. Exp. Sta., 1920.

A. D. MacGillivray, *The Coccidæ.* Scarab Press, Urbana, Ill. 1921. (See complete Bibliography.)

habits, so the large majority are to be considered as of real economic importance.

Many species, particularly the unarmored forms, also excrete large amounts of honeydew and often cause dense smutting of the host plants.

Natural enemies [1] are of great importance in the control of these serious pests. Since the discovery and importation of the vedalia into California, and its success in the subjugation of the cottony cushion scale, there has been a nation-wide interest in this phase of insect control. The State of California has maintained for years a special institution, the State Insectary, to conduct this work. There have been imported into California a great many predaceous and parasitic insects some of which are doing effective work, while others have never become established in the orchards. So great is the annual expenditure in the regular routine of fumigation and spraying operations for scale insects, that every effort is being made to reduce it by the gradual substitution of the biological control method. The most important predators and parasites will be described elsewhere.

The artificial control of scale insects is quite beyond the experimental stage and consists in spraying and fumigation.

SPRAYS—The important sprays are lime-sulfur and oil emulsions.

Lime-sulfur.—The use of lime-sulfur is limited to the control of the San José scale and is applied as a dormant spray in the proportions of 1 gallon to 9 gallons of water. In many sections the lime-sulfur is being replaced by the more satisfactory crude oil and distillate emulsions.

Crude Oil Emulsion.—The use of crude oil or petroleum is limited to the winter spraying of deciduous trees when the buds are entirely dormant, and is generally applied from November to February. The crude oil emulsion is especially recommended for such armored scales as the San José scale, Italian pear scale, oyster shell scale, and such other species as infest deciduous trees and shrubs. The natural crude petroleum, testing about 23° Baumé, is preferred, but heavier grades may also be used if the asphaltum content is not too high. The crude oil emulsions may be had from commercial spray manufacturers in which case full directions for use accompany the containers. A satisfactory home-made product may be obtained by using the following formula:

Water	175 gallons
Liquid soap	3 gallons
Natural crude petroleum (21°–24° Baumé)	25 gallons

Partly fill the spray tank with water, add the liquid soap, agitate thoroughly for one minute, add crude oil and continue the agitation while running in the remainder of the water. If liquid soap cannot be obtained, use 20 pounds of fish oil soap dissolved in 10 gallons of boiling water to which 3 pounds of caustic soda or lye have been added. To kill moss or lichens on fruit trees, add 12 pounds of caustic soda or lye to the formula.

During the spraying operation this emulsion should be thoroughly agitated and great care taken to wet all of the twigs. From 3 to 5 gallons should be used on a tree.

[1] H. S. Smith, "Biological Control of Mealybugs in California." *Mthly. Bul.*, Cal. State Dept. Agr. 9, 1920, p. 104. "Biol. Control of Black Scale in Calif." *Mthly. Bul.* Cal. State Dep. Agr. 10, 1921, p. 127.

The Distillate or Petroleum Emulsions.—The distillate emulsions are suitable for the control of all types of scale insects on deciduous and evergreen trees and shrubs, and are among the most useful sprays for other sucking insects as well. They are specially recommended for the soft, cottony scales, mealybugs, and unarmored scales, but are also good for armored scales on evergreen trees. The greater efficiency of crude oil emulsion for all scales on deciduous plants should not be overlooked in this connection. The more important distillate sprays are:

Kerosene Emulsion.

Kerosene	15 gallons
Liquid soap	¾ gallon
(Or hard soap	4 pounds)
Water to make	200 gallons

If liquid soap is available it is preferable to hard soap, since no heating is required. Hard soap, preferably fish oil soap, is cut in thin slices and dissolved in hot water. The soap is placed directly in the spray tank with 10 or 15 gallons of water or more (the exact amount is not important) and the engine then started. The oil is now added slowly and the materials are emulsified by being run through the pump under pressure. After a few minutes the rest of the water may be added, and the spray is ready to be applied.

Tree Distillate Emulsion.

Tree distillate (31°–32° Baumé)	4 gallons
Liquid soap	¾ gallon
(Or hard soap	5 pounds)
Water	200 gallons

These materials are emulsified in the manner explained for the kerosene emulsion above. If the distillate is used without soap, the following is the formula:

Straight Tree Distillate—Mechanical mixture.

Tree distillate (31°–32° Baumé)	4 to 6 gallons
Caustic soda (95 per cent)	7 pounds
Water	200 gallons

In the case of the straight distillate, the oil is kept in suspension in the water by agitation and forms an unstable mechanical emulsion, which separates quickly on standing. In using this it is necessary to have the spray outfit equipped with a powerful and efficient agitator, which must be kept going continuously during the spraying operations.

The use of petroleum-distillate sprays against black scale on olive trees is now being recognized as profitable. For this purpose the heavier distillates of 28° to 30° Baumé, being more effective, are used, since olive foliage is very resistant to spray injury, and also because the spray can be applied through the winter months when low temperatures and high humidities are the rule.

Distillates of this density are also much used as dormant sprays on deciduous trees, although crude oil sprays are replacing distillates more and more for this purpose.

Miscible Oil.—The miscible oil sprays are manufactured oil sprays which have much the same use as the distillate emulsions. They are specially recommended for mealybugs and the soft and unarmored scales.

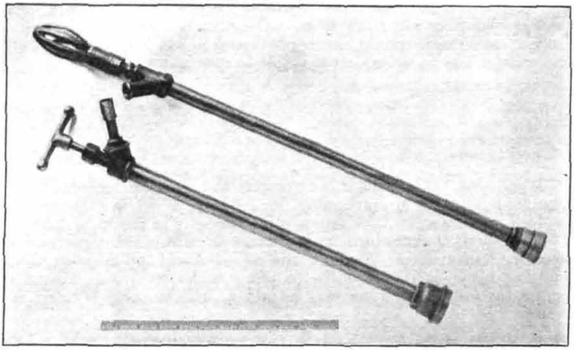

Fig. 155.—Two common types of spray gun. Spray guns are especially valuable for spraying dormant deciduous trees for scale insects, but may be used for many kinds of spraying work.

Crude Carbolic Acid and Distillate Emulsion.—This makes an excellent homemade substitute for miscible oil for the control of mealybugs.

Fish oil soap (or liquid soap, 5 gallons)	40 pounds
Crude carbolic acid (25 per cent)	5 gallons
Distillate (27°–28° Baumé)	5 gallons
Water to make	50 gallons

Completely dissolve the soap in hot water, add the carbolic acid and distillate, and heat to the boiling point for twenty minutes (reserve some water to add in case the mixture begins to boil over). For use, add 20 gallons of water to every gallon of the above solution. The emulsion needs little or no agitation.

Lubricating Oil Emulsion.

Lubricating oil	4 to 6 gallons
Calcium caseinate	½ pound
Water to make	100 gallons

Mix the calcium caseinate in a small quantity of water, add the oil, stir and agitate thoroughly in the tank with the remainder of the water.

Fumigation.—Fumigation with hydrocyanic acid gas for the control of scale insects is almost entirely limited to citrus trees and is still the most reliable means of controlling these pests in the citrus orchards. At the present time liquid hydrocyanic acid gas is most used. The subject of orchard fumigation is so far reaching that no attempt to describe the process will be undertaken here.

MONOPHLEBINÆ (Subfamily).[1] The Giant Coccids. **The cottony cushion or fluted scale,** *Icerya purchasi* Maskell (Fig. 156), is readily distinguished by the accompanying illustration. The mature females have

FIG. 156.—The cottony cushion scale, *Icerya purchasi* Maskell. A typical infestation on spiny acacia. Also see Fig. 498.

bright orange red, yellow, or brown bodies, often partially or entirely covered by yellow or whitish wax, and having at the posterior end a large, elongated white, fluted, cottony egg sac which often makes the combined

[1] The writer is indebted to G. F. Ferris for assistance in the systematic arrangement and synonymy of the *Coccidæ*.

length from 10 to 15 mm. Inside the egg sacs are hundreds of bright red, oblong eggs which hatch into bright red young with dark antennæ and legs and a number of long hairs at the posterior end of the body. The red males emerge from small, delicate white cocoons, and are scarcely more than 1 mm. long. They have the characteristic two wings and the long, white, anal filaments. The species breeds throughout the year, being only retarded during the winter months; from a few to many broods are produced annually. Enormous numbers may so cover the hosts as to make them appear whitewashed or covered with cotton, and very severe damage may result if not checked. This very interesting scale insect was first introduced into California from Australia in 1868 on acacia, and subsequently spread to the ornamental plantings and citrus orchards of the southern part of the State. So rapid was the spread and increase that in 1886 it became a severe scourge and threatened with complete destruction the citrus industry in California. It became known as the Australian bug and white scale, in addition to the other common names. It feeds on a great number of plants including acacias, alfalfa, almond, apple, apricot, boxwood, buckeye, California sage, castor bean, casuarina, Cedar of Lebanon, chrysanthemum, citron, cypress, fig, garrya, geranium, goldenrod, grape, grapefruit, Bermuda grass, sweet gum, Guadalupe palm, hackberry, ironwood, Boston ivy, knotweed, lambsquarters, laurel, lemon, lime, locust, magnolia, maple, mistletoe, nettle, nightshade, holly oak, laurel oak, white oak, orange, peach, pear, pecan, pepper, pigweed, pine, pittosporum, poinsettia, pomegranate, potato, purslane, quince, ragweed, rose, spearmint, sunflower, St. John's wort, verbena, English walnut, and willow. From the above list it is seen that the insect feeds on a very great variety of plants. The Winter Nellis pears in some districts have become very seriously infested by the scale and, strange as it may seem, the usual natural enemies appear not to attack it on such trees at all. The distribution in the west comprises central and southern California and a few scattered spots in Arizona.

This is one insect which is, with the exception of the few cases on pear trees, held in complete subjugation by its natural enemies. So remarkable have been the combined efforts of these natural enemies that if the scale does appear in an isolated place it is a simple matter to quickly control it by introducing the natural enemies, and more particularly the vedalia.

Small infestations may also be controlled by spraying with crude carbolic acid emulsion, miscible, or distillate oil sprays as suggested at the beginning of this chapter.

Icerya rileyi Cockerell occurs on covillea and mesquite in Arizona and New Mexico.

MARGARODINÆ (Subfamily).[1] Sinoran Coccids. **The piñon needle scale,** *Matsucoccus*[2] *acalyptus* Herbert, is a flat, elongate-oval, wrinkled, brown species, 2 to 3 mm. long and less than half as wide. It occurs on the exposed portions of the needles of the single-leaf piñon in southern Idaho. **The three-leaf pine scale**, *M. fasciculensis* Herbert, is somewhat larger, 3 to 3.5 mm. long and of much the same appearance. It lives between the pine needles near or within the sheath of the digger and yellow pines in California.

[1] MacGillivray places these members in the subfamilies *Kuwaniinæ* and *Xylococcinæ*.
[2] *Americoccus* of MacGillivray, *Proc. Ent. Soc. Wash.*, 23, 1921, p. 20.

The sycamore scale, *Stomacoccus platani* Ferris,[1] is a very small, dark yellow, elongated species, the mature females being but 1.6 mm. long. Its presence is easily recognized by the yellow spots produced on the leaves. It feeds on the bark and leaves of native and ornamental sycamores in California and Arizona.

The alder scale, *Xylococcus*[2] *betulæ* Pergande (*X. alni* Florence), has an oval, dark red body and is found in rough, swollen places usually in the crotches of the trees. It may be located by slender, white, waxy threads which extend from the hidden bodies. It occurs on birch in the Eastern States and on alder in Oregon and California. *X. macrocarpæ* Coleman lives on Monterey cypress in the native forests in Monterey County and on incense cedar in the Sierra Nevada Mountains, California. It is often a serious pest of young cedars in the shady forests. *X. quercus* Ehrhorn attacks the coast live oak and California black oak in California.

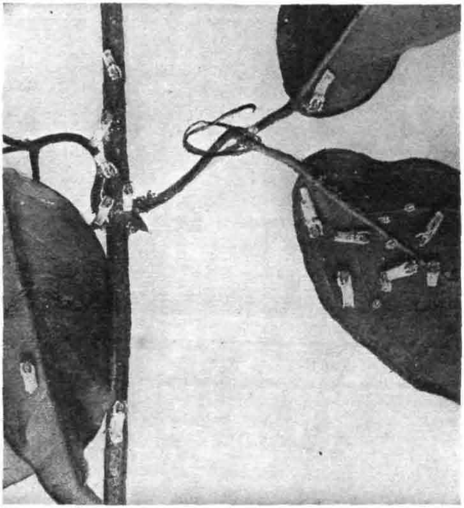

FIG. 157.—The greenhouse orthezia, *Orthezia insignis* Douglas. Young and mature females on bignonia.

ORTHEZIINÆ[3] (Subfamily). Ensign Coccids. **The greenhouse orthezia,** *Orthezia insignis* Douglas (Fig. 157), is the most common member of this subfamily. The bodies of the females are pale brown or dark green and have conspicuous dorsal and lateral white waxy plates, and a long, white, somewhat flattened egg sac projecting posteriorly which is often twice

[1] G. F. Ferris, *Can. Ent.*, 49, 1917, p. 375. Orig. desc.

[2] Laura Florence, "Pacific Coast Species of *Xylococcus*." *Ann. Ent. Soc. Am.*, 10 1917, p. 147.

[3] H. Morrison, Classif. of Scale Insects of the Subfamily, *Ortheziinæ*. *Jour. Agr. Research*, 30, pp. 97–154, 1925.

the length of the body, and which measure together 6 to 8 mm. The young have only the dorsal ridges and the lateral margins of white wax. The males are dark green and very small. This scale is a tropical species usually found in greenhouses in our regions, but it has been taken out of doors in Southern California. It feeds on cherry, bignonia, bougainvillæa, chrysanthemum, citron, coffee, coleus, cuphea, gardenia, grapefruit, ironweed, jacaranda, lantana, ligustrum, lemon, moon flower, orange, palm, pepper, pigweed, rose, sage, strawberry, tea, tomato, verbena, yarrow, and many other tropical plants. So serious is it as a pest of lantana that in Hawaii it is called the lantana blight.

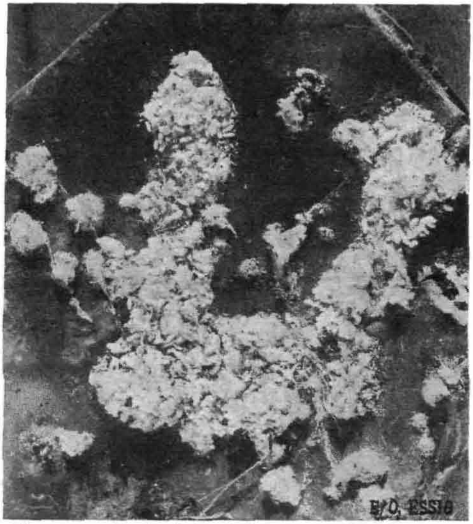

FIG. 158.—The cottony cochineal scale, *Dactylopius tomentosus* (Lamarck), on opuntia cactus.

O. annæ Cockerell has a long, fluted, white egg sac and occurs on chenopodium, atriplex, and kochia in New Mexico, Colorado, Arizona, and California. **The California sage orthezia,** *O. artemisiæ* Cockerell, is a large species with the body almost entirely covered with wax and with a long, cylindrical, fluted, white egg sac which curves upward. The mature females with the egg sac measure from 6 to 10 mm. It feeds on the stems of California sage in Southern California and New Mexico. *O. garryæ* Cockerell has a pale green body. It infests garrya in New Mexico, and *Flendera* in Arizona. **The grass orthezia,** *O. graminis* Tinsley, has a dark body 2 to 3 mm. long with a fluted, white ovisac from 6 to 13 mm. long. It occurs on the culms and blades of wild grasses in New Mexico and California. *O. lasiorum* Cockerell and *O. olivacea* Cockerell occur in nests of ants (*Lasius* sp.) in Colorado. *O. nigrocincta* Cockerell

infests *Gutierrezia* in New Mexico, Arizona, and California. **The western orthezia,** *O. occidentalis* Douglas (*O. californica* Ehrhorn), is reported from eriophyllum in California, from ants' nest in Colorado and New Mexico, and has been taken from roots of apple nursery stock shipped from Oregon into California. In the latter case it may have been taken up with the soil.

DACTYLOPIINÆ (Subfamily). Cochineal Scales. **The cottony cochineal scales,** *Dactylopius tomentosus* (Lamarck) (Fig. 158) and *D. confusus* (Cockerell) (*Coccus*), are readily recognized by the abundance of white, cotton-like wax which entirely covers the cochineal red bodies beneath. The two species are easily confused. G. F. Ferris believes the former to be the common form occurring in Southern California and Arizona, and previously described by the writer as *D. confusus* (Ckll.).[1] Both species are

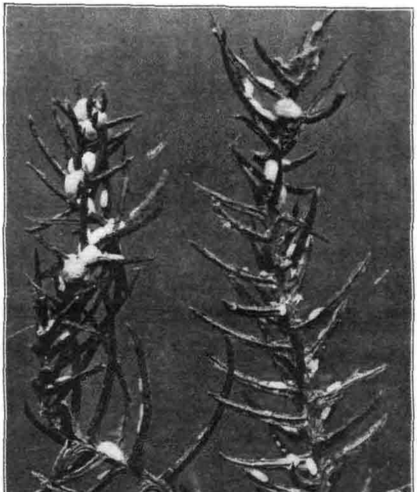

FIG. 159.—The araucaria scale, *Eriococcus araucariæ* Maskell. The bodies are enclosed in white felt-like sacs.

often abundant on opuntia cactus, often completely covering the surface, and overlap in their distribution, occurring chiefly in the arid southwest extending into Mexico. The latter also occurs in California and Arizona, and is reported in New Mexico, Colorado, and Montana.

The araucaria scale, *Eriococcus araucariæ* Maskell (Fig. 159), is easily distinguished by the pure white, felt-like, oval sacs which enclose the bodies and eggs of the females. It is often abundant and destructive to Norfolk Island pine, having been imported into California from Australia and New Zealand. It occurs also in India, Hawaii, and

[1] E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d Ed., 1915, p. 122.

Africa. The parasite, *Aphycomorpha araucariæ* Timberlake,[1] has been reared from specimens of this scale from New Zealand, Australia, and also in Hawaii, and probably occurs in California. There are a number of species of *Eriococcus* all of which are enclosed in a similar white, felt-like sac and may be often determined by the host plant. *E. adenostomæ* Ehrhorn occurs in California on greasewood. *E. coccineus* Cockerell is often abundant on surface and spines of cacti from Mexico. It is established on ornamental cacti in Southern California. *E. gillettei* Tinsley inhabits the red cedar or savin in Colorado and New Mexico. *E. pœnulatus* Ferris infests California sage in California. *E. palustris* Dodds occurs on salt marsh grass in the San Francisco Bay region, California. (C. T. Dodds, *P. C. Jour. Ent. and Zoöl.*, 15, pp. 57–60, 1923.) *E. quercus* (Comstock) (*E. howardi* Ehrh.) (Fig. 160) is common on various oaks in New Mexico, Utah, and California. *E. tinsleyi* Cockerell inhabits the roots and branches of atriplex which touch the ground, in New Mexico. *E. villosus* Ferris occurs on wild buckwheat in Santa Clara County, California.

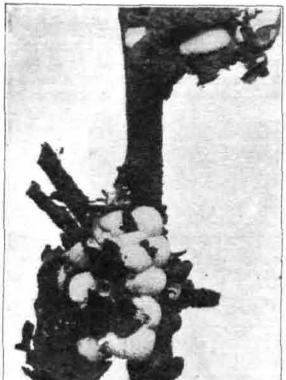

FIG. 160.—The oak eriococcus, *Eriococcus quercus* (Comstock), on black oak. The bodies are enclosed in the white felt-like sacs.

The European elm scale, *Gossyparia spuria* (Modeer) (*G. ulmi* Linn.)[2] (Fig. 161), is a European insect which is slowly becoming distributed throughout the Western States, being known in New Mexico, Colorado, Nevada, Idaho, and California, as well as in many of the Eastern States. The adult females are readily recognized by the white cottony fringes or rings around the oval, dark reddish brown bodies which measure 3 to 4 mm. in length. They are often crowded so abundantly on the bark of the trunks and limbs of the trees as to be very conspicuous. The young are entirely covered with a thick, powdery wax giving them the appearance of mealybugs. The minute males develop from small white cocoons which are often present in great numbers. The eggs are oblong, pale yellow, and hatch so quickly that they are seldom abundant. This scale is single-brooded, but is exceedingly prolific and is a severe pest of many species of elm trees wherever found. Ornamental trees are rendered black and unsightly because of the honeydew and black smut fungus, and sidewalks are made sticky with the honeydew. Control measures consist in the application of miscible, distillate, or crude oil sprays during the dormant period of the trees, by means of powerful spraying outfits. Thorough washing in the spring when the buds are swelling, with high pressure,

[1] P. H. Timberlake, *Proc. Hawaii Ent. Soc.*, 4, 1919, p. 190.

[2] S. B. Doten, Bul. 65, Nevada Agr. Exp. Sta., Feb. 1908. *Mthly. Bul.*, Cal. Hort. Com. 1, 1912, p. 89.
E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed., 1915, p. 119.
G. M. List, Circ. 29, Colo. Agr. Col. 1920.

removes many of the bodies of the females which are swollen with eggs and easily knocked off, and if repeatedly and thoroughly done may afford satisfactory control; but the oil sprays are much more likely to secure the desired results.

The gall-like coccids belonging to the genus *Kermes* are interesting because of the almost globular, gall-like appearance of the mature females. The immature forms are somewhat like the soft scales. They inhabit the twigs of oak trees and are commonly

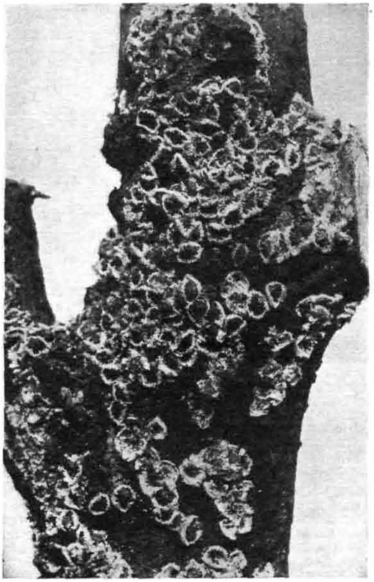

FIG. 161.—The European elm scale, *Gossyparia spuria* (Modeer). Adult females partially enclosed in white felty sacs. On elm.

mistaken for small oak galls. **Austin's kermes**, *Kermes austini* Ehrhorn, is smooth, spherical, 4 to 5 mm. in diameter, pale brown, with several irregular, paler stripes parallel with the segments. It occurs on oak in Southern California. **The Arizona kermes**, *K. arizonensis* King, is smooth, globular, brown with darker marbled effect. The diameter is about 3 mm. It is found on oak in Arizona. *K. ceriferus* Ehrhorn is smooth, globular, dark brown, with darker mottlings on the surface which may be covered with a fine, white powder when living. The diameter varies from 3 to 6 mm. It occurs on oak in Arizona. **Cockerell's kermes**, *K. cockerelli* Ehrhorn, has the surface corrugated or lobed on the dorsum, is somewhat globular, 3 to 5 mm. in diameter, and usually of

a uniform, pale brown. It is the commonest species throughout Central California and occurs chiefly on the valley and black oak. **The black-punctured kermes,** *Kermes nigropunctatus* Ehrhorn and Cockerell (Fig. 162), is another very common species throughout California and the most abundant species in the southern part of the States. It is much like *K. cockerelli* Ehrh., but is paler in color and has smaller dorsal lobes. The size also averages larger. It occurs on the black oak and coast and interior live oaks in California and Mexico. *K. essigi* King and *K. branigani* King are simply forms of this species. **Gillette's kermes,** *K. gillettei* Cockerell, is a large, sub-globular species, attaining a diameter of 8 mm. The surface is smooth or somewhat corrugated as in

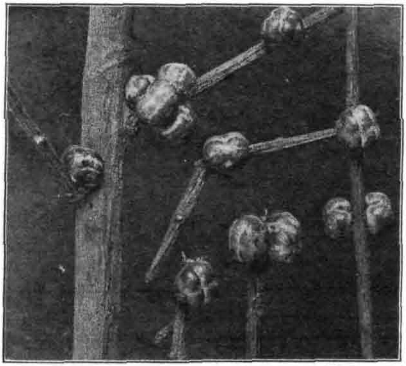

FIG. 162.—The black-punctured kermes, *Kermes nigropunctatus* Ehrh. and Ckll., on twigs of coast live oak.

K. cockerelli Ehrh., and the color varies from pale yellow to dark gray or brown with paler mottlings. It occurs on oak in Colorado, New Mexico, and Texas. **The cottony kermes,** *K. shastensis* Ehrhorn, is globular, smooth, shining brown, 5 mm. in diameter, and entirely covered with a thick, white, cottony wax. It infests the interior live oak in the vicinity of Mt. Shasta and Lake Tahoe, California.

The gall-making coccid, *Olliffiella cristicola* Cockerell, is a flat, oval, dark purplish brown or orange species with elevated margins. It fits snugly into a slanting, conical leaf gall which has a slit-like opening on the dorsal surface, protrudes ventrally, and has a terminal curved tip so that the whole gall resembles a miniature acorn or a large thorn. The color is green with a red blush. It is at times abundant on the leaves of Wright's oak in New Mexico.

CYLINDROCOCCINÆ. (Subfamily). Lubberly Coccids. **The red date palm or Marlatt scale,** *Sphærococcus marlatti* (Cockerell) (*Phœnicococcus*) [1] (Fig. 163), is the most serious enemy of the date palm in Arizona and Southern California. The adult females are dark reddish purple, oval in form, and from 1 to 1.4 mm. long. The bodies rest on masses of white, cotton-like wax which may partially or entirely envelop them. They

[1] T. D. A. Cockerell, Bul. 56, Ariz. Agr. Exp. Sta. 1907, p. 191.
E. O. Essig, *Inj. & Ben. Insects Cal.*, 2d ed. 1915, p. 123.
A. D. Borden, *Jour. Agr. Research*, 21, 1921, p. 659.
H. Morrison, *Jour. Agr. Research*, 21, 1921, p. 669.

are crowded together in dense masses in the unfolding leaf boles and fruit stems at the bases of the branches and among the superficial roots, where they are usually completely hidden and thoroughly protected. The males are wingless. The scale is found in all stages of development throughout the year, there being from two to three overlapping generations a year with continuous, prolific breeding. During the fall and winter all of the scales are hidden beneath the fiber and leaf bases and on the stems of the fruit of the current year. The chief migration of the young to new growths occurs in the spring, with a smaller movement again in the fall. This scale is an old world species occurring in the date-growing districts of Northern Africa, in Palestine, and Arabia. It was carried to Arizona in 1889 and subsequently to California with the date palms and offshoots which afford the chief means of distribution. It has become such a serious pest that the Federal Horticultural Board has placed a Federal quarantine on the infested areas in order to prevent further dissemination in newly developed date-growing sections. There are no natural enemies of importance known in our region. It is hoped that an attempt will be made by the proper authorities to introduce the native predators and parasites from the native habitats of the scale into this country. Control measures consist first in the removal of all surplus branches and other debris from the trees, followed by a carbolic acid and distillate emulsion or a miscible oil spray as formulated at the beginning of this chapter. According to A. D. Borden,[1] the spray should be applied during the migratory periods which permits two periods of application a year: the first from January 1 to April 1, and the second from May 15 to August 15. During these periods from three to four applications may be made if necessary. The spray should be thoroughly applied under strong pressure from 200 to 250 pounds, with a coarse angle nozzle, preferably from an elevated platform. The offshoots should be immersed twice in a bath of the above mentioned solutions for a period of 15 minutes with an interval of 24 hours, after which they should be carefully rinsed and retreated if the scales are not all killed.

Fig. 163.—The red date palm or Marlatt scale, *Sphærococcus marlatti* (Ckll.). Infestation in unfolding shoot of date palm.

[1] *Jour. Agr. Research*, 21, 1921, p. 667.

The cottony cypress scale, *Ehrhornia cupressi* (Ehrhorn) (*Sphærococcus*),[1] has nearly a globular, pale pink body 1.5 x 1.1 mm., which is usually imbedded in pits or cracks of the bark and covered with long, loose, white cottony wax. The antennæ are 6-jointed. The young are pale yellow. The presence of the insect is indicated by the loose, cottony covering on the branches. It is sometimes a serious pest of Monterey cypress in California and also attacks Guadalupe cypress, Arizona cypress, and incense cedar. According to F. B. Herbert,[2] the Italian and Oriental cypress are immune. It occurs in the Sierra foothills and coastal plains of California. *E. graminis* Ferris is bright yellow, covered with loose white flocculence, occurring in the cracks and under the scales on the roots of grasses in Monterey County, California.

PSEUDOCOCCINÆ (Subfamily). Mealybugs.[3] The members of this subfamily are among the most serious pests to plant life. They are characterized by the flattened, elongate oval bodies which are thinly or thickly covered with white, powdery wax which extends from the sides in a series of short filaments, with usually two longer ones at the posterior end. The antennæ are normally 8- or 9- or, rarely, 7-segmented, and the feet terminate in a single claw which is not toothed on the inner margin. Excepting *Antonina* they retain the appendages throughout life and move freely but slowly at will. The size varies from the very minute young to the mature females which average from 3 to 7 mm. in length. The eggs are oval, pale yellow, orange or purple and laid in cottony masses which may cover large areas of the infested plants. A few species bring forth living young. The young and adults excrete quantities of honeydew and cause serious smutting of the fruit and foliage. The males mature in small, delicate, white cocoons, and often become exceedingly abundant especially at sundown on warm, late summer and fall evenings. Mealybugs feed on all parts of the plants above and below ground, which makes control measures very difficult. Breeding continues throughout the summer and fall, and the greatest numbers of all stages are present in the fall and early winter months from August 15 to December 15. Young are present throughout the entire season and the greatest numbers reach maturity in mid- or late summer when egg laying commences and continues until winter. All stages are in least evidence from April to July in the Western States. These insects prefer a moderate or warm, moist climate, and are often very abundant in greenhouses, lath houses, and along the coast of Central and Southern California. A number of species, however, inhabit the warm, dry regions. Many native and introduced natural enemies are responsible for great reductions in numbers, but only temporarily control the outbreaks. To secure satisfactory control with natural enemies, it is also necessary to control the Argentine ant in order to allow the parasites and predators complete freedom. They are listed under the different species because some of them are selective in their food habits. Artificial control consists in spraying and fumigation. The chief sprays are miscible and soluble oils, and carbolic acid and distillate emulsions, all of which readily dissolve

[1] G. F. Ferris, *Can. Ent.*, 42, 1911, p. 277. The position of this genus is doubtful.
[2] *Jour. Econ. Ent.*, 12, 1919, p. 335.
[3] E. O. Essig, "Genus *Pseudococcus* in California." *P. C. Jour. Ent.*, 1, 1909, p. 35. "Mealy Bugs of California." *Mthly. Bul.*, Cal. State Com. Hort. 3, 1914, p. 97.
P. E. Smith, "Specific Characters Used in the Genus *Pseudococcus*." *Ann. Ent. Soc. Am.*, 4, 1911, p. 309.
C. P. Clausen, *Mealy Bugs of Citrus Trees*. Bul. 258, Cal. Agr. Exp. Sta. 1915.
G. F. Ferris, "The California Species of Mealy Bugs." *L. Stanford Jr. Univ. Pub. Univ. Ser.*, 1918.

the protective wax covering and penetrate to the bodies and eggs. Continued hosing or spraying with water gives very satisfactory results in reducing mealybugs or ornamental plants about the house. Everything that is done for mealybugs must be thorough and repeated as often as is

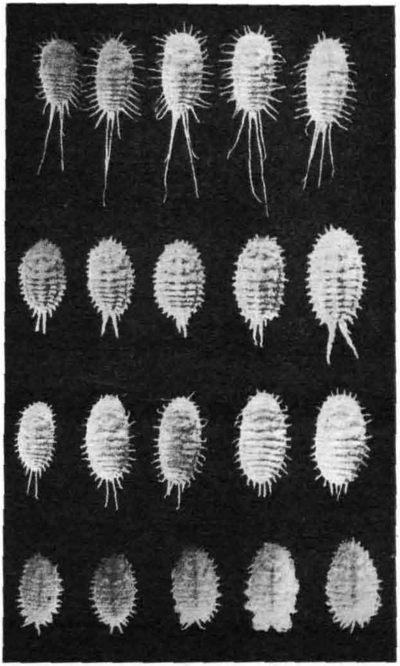

FIG. 164.—Common mealybugs. Top row, the long-tailed mealybug, *Pseudococcus longispinus* (Targ.); second row, the citrophilus mealybug, *P. gahani* Green; the third row, Baker's mealybug, *P. maritimus* (Ehrh.); bottom row, the citrus mealybug, *P. citri* (Risso). (After Clausen.)

necessary to secure the proper reduction of numbers. It may also be necessary to make a basin about the bases of the infested plants and fill it with the foregoing sprays in order to kill those on the roots. There is a large number of species, the more important ones of which are included. Many of the species were originally described in the genus, *Dactylopius*.

The golden mealybug, *Pseudococcus aurilanatus* (Maskell), has a reddish purple body which is partially covered with tufts of a bright yellow, waxy secretion. The purple eggs are enclosed in a whitish or yellow ovisac. This species was introduced into California from Australia and New Zealand on Norfolk Island pine and Monkey Puzzler. It also occurs on *Agathis* spp. It is most common in Southern California, and occurs as far north as San Francisco Bay.

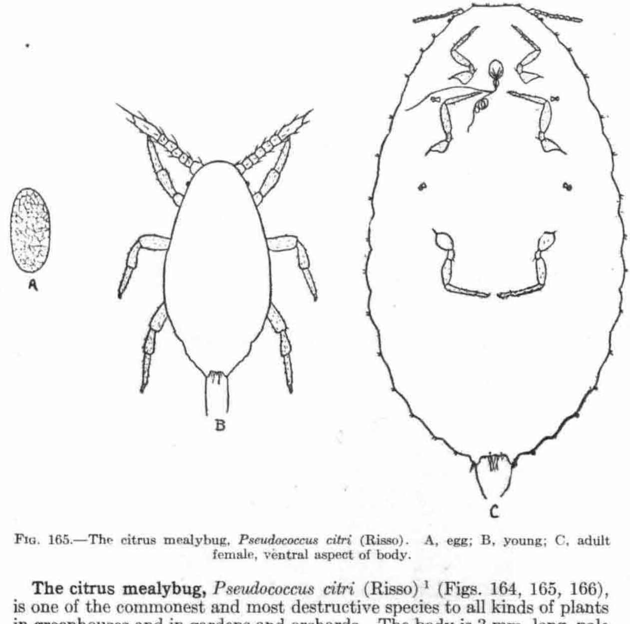

FIG. 165.—The citrus mealybug, *Pseudococcus citri* (Risso). A, egg; B, young; C, adult female, ventral aspect of body.

The citrus mealybug, *Pseudococcus citri* (Risso)[1] (Figs. 164, 165, 166), is one of the commonest and most destructive species to all kinds of plants in greenhouses and in gardens and orchards. The body is 3 mm. long, pale yellow, thickly covered with white, powdery wax, with short lateral and anal wax filaments. The oval yellow eggs are laid in loose, cottony masses of from 200 to 350. The male cocoons are somewhat cylindrical, delicate,

[1] E. O. Essig, *P. C. Jour. Ent.*, 2, 1910, p. 289. Complete Bibliography.
R. S. Woglum and J. D. Neuls, *Farmers' Bul.* 862, U. S. Dept. Agr. 1917.
G. F. Ferris, "The California Species of Mealy Bugs." *Ll. Stanford Jr. Univ. Pub. Univ. Ser.* 1918. Also *Jour. Econ. Ent.*, 12, 1919, p. 292.
A. D. Borden, *Farmers' Bul.* 1309, U. S. Dept. Agr. 1923.

cottony masses which often occur in great numbers on the living and dead leaves. The young females often occur in great masses in the crotches, around wounds, in cracks, and on the foliage and fruit as well as on the roots of the trees. The greatest numbers occur in the late summer, fall, and early winter months, when the most serious damage to the plants results. It is an omnivorous feeder occurring on a wide variety of plants in the greenhouses of most of our area, but also common in the open in Southern California. Among the common food plants are avocado, begonia, bottle brush, bouvardia, citron, coffee, coleus, cotton, deer-brush, ferns, fuchsia, geranium, Guadalupe Island palm, English ivy, lemon, moon flower, nettle, nightshade, oleander, orange, passion flower, peony,

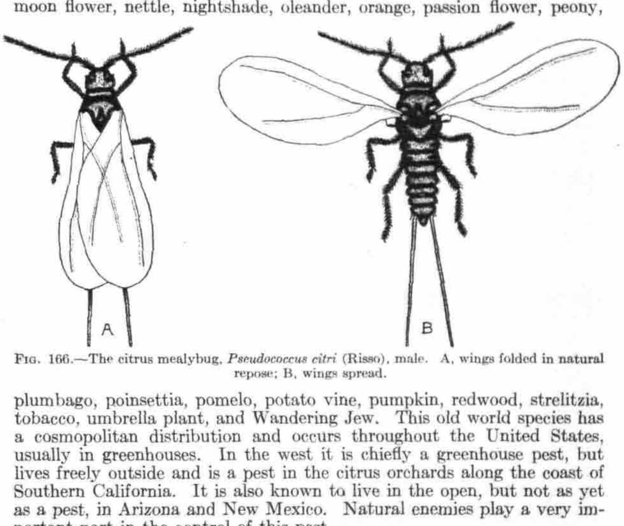

FIG. 166.—The citrus mealybug, *Pseudococcus citri* (Risso), male. A, wings folded in natural repose; B, wings spread.

plumbago, poinsettia, pomelo, potato vine, pumpkin, redwood, strelitzia, tobacco, umbrella plant, and Wandering Jew. This old world species has a cosmopolitan distribution and occurs throughout the United States, usually in greenhouses. In the west it is chiefly a greenhouse pest, but lives freely outside and is a pest in the citrus orchards along the coast of Southern California. It is also known to live in the open, but not as yet as a pest, in Arizona and New Mexico. Natural enemies play a very important part in the control of this pest.

The white sage mealybug, *Pseudococcus crawi* (Coquillett), has a pale yellow body, entirely covered with thick plates of white, cottony wax. The lateral wax filaments are very distinct and about one-fourth as long as the width of the body. The anal filaments vary from one-third to one-half the length of the body and are straight or curved inwardly, forming an acute angle at the base. It feeds chiefly on the stems and leaves of white sage, but also occurs on artemisia in Southern California. In the San Francisco Bay Region Ferris reports it on greasewood, tan oak, and interior live oak.

The eriogonum mealybug, *Pseudococcus eriogoni* Ehrhorn (*Erium eriogoni* Ehrh., *P. yerba-santæ* Essig), is yellow, entirely covered with fine, white wax with conspicuous marginal filaments often enclosed in a thin white ovisac. It occurs on the roots and tops of buck brush, eriogonum, hedge nettle, ragweed, tibinagua, wood violet, and yerba santa in Central and Southern California.

FIG. 167.—The citrophilus mealybug, *Pseudococcus gahani* Green. Typical colony on orange leaf.

The citrophilus mealybug, *Pseudococcus gahani* Green (*P. citrophilus* Clausen)[1] (Figs. 164, 167, 168), is coming to be one of the worst pests throughout the coastal area of California. The mature females vary from 3 to 6 mm. in length. The body is entirely covered with thick, white wax with four dorsal longitudinal rows of small depressions, the two median rows being most conspicuous. The lateral wax filaments are slender and very short. There are two pairs of anal filaments, the outer pair longer than the lateral filaments but less than half the length of the inner pair which are about one-third the length of the body, stout, usually pointed at the tip, and held parallel or at an acute angle. The male cocoons, eggs, and egg masses are much like those of the citrus mealybug. The males are exceedingly abundant in the late afternoons and evenings during the summer and fall. They hover over the infested shrubbery in countless thousands. As previously intimated, this species is becoming more serious each year. It thrives in the cool coastal areas of California and ranges from the San Francisco Bay Region to the southern part of the State. It is very prolific and thrives under cooler outside conditions than does the citrus mealybug. The roots and tops of very many native and ornamental trees and shrubs, flowers, deciduous, walnut and citrus orchard trees, berries, and almost everything excepting grasses and conifers, are infested. It is a serious pest of orange and lemon trees wherever it occurs in the coastal area, and is particularly destructive to shrubs and trees in parks and to street plantings. Pittosporum and privet hedges, vines, eugenia, Mexican orange, grevillea, sunflower and related plants, foxglove, nightshade, potato, poison hemlock, columbine, and a countless list of others are seriously infested. It has been repeatedly taken in Berkeley, California, by the writer on apple,

[1] C. P. Clausen, Bul. 258, Cal. Agr. Exp. Sta. 1915, p. 30.
G. F. Ferris, *Jour. Econ. Ent.*, 12, 1919, p. 292.

cherry, peach, pear, plum, and prune, but as yet has not become a pest in the deciduous orchards of the State.

The Japanese mealybug, *Pseudococcus krauhniæ* (Kuwana),[1] very closely resembles the citrus mealybug and is easily mistaken for it. There is a marked difference in the egg mass which is greatly elongated or even serpentine in form. It is a Japanese species, occurring on *Krauhnia* sp., in Japan, which is known only in the Ojai Valley, Ventura County, California, where it infests orange, wistaria, and Japanese persimmon. It is reported on western yew in New Jersey.[2]

The long-tailed mealybug, *Pseudococcus longispinus* (Targioni) (Fig. 164), is a cosmopolitan species easily distinguished by the long, white anal filaments, which are often as long or longer than the body, and by the general absence of egg masses, the species being usually ovoviviparous. It is a tropical species occurring chiefly in greenhouses throughout our country, but also infests the gardens in the mild coastal region of Southern California. The host plants are numerous, some of which are avocado, banana, begonia, betel nut, cactus, calla, cineraria, citron, coleus, croton, dracaena, eucalyptus, ferns, fig, fuchsia, grapefruit, grape, guava, honeysuckle, lemon, mango, moon flower, oleander, orange, Guadalupe palm, pandanus, plum, poinsettia, primrose, rubber, sago palm, strelitzia, umbrella plant, carob, zamia, and many other tropical and subtropical plants.

Baker's or the grape mealybug, *Pseudococcus maritimus* (Ehrhorn) (*P. bakeri* Essig, *P. obscurus* Essig, *P. omniveræ* Hollinger)[3] (Fig. 164), is characterized by the thin, white wax covering; short, slender lateral filaments; and slender anal filaments which may vary from one-fourth to nearly one-half the length of the body. The egg masses are much like those of the citrus and citrophilus mealybugs. This species has a wide range of food plants, occurring naturally on the roots or tops of clover, elder, buckeye, eriogonum, malva, nightshade, wild sunflower, and willow. It has gone over to many cultivated plants such as alfalfa, apple, California poppy, columbine, Canary date palm, carnation, grevillea, English ivy, ginko, European grape, laburnum, lemon, orange, Mexican orange, passion flower, pear, potato, potato vine, Japanese quince, strawberry, English walnut, and Japanese yew. In California it is most serious as a pest of grapes in the San Joaquin Valley and to pears in the Santa Clara Valley, being particularly troublesome to the fruit. In Florida it is reported on avocado, sweet potato, and tomato, and occurs on various greenhouse plants in England.[4] In the west it is so far reported only in California. The predaceous enemies are practically the same as those of the citrus mealybug. Many native internal parasites have been reared in various parts of California. Natural enemies promise the best means of control on grapevines

[1] G. F. Ferris, "Cal. Species of Mealy Bugs." *L. Stanford Jr. Univ. Pub. Univ. Ser.* 1918, p. 43. *Jour. Econ. Ent.*, 12, 1919, p. 294.

[2] H. B. Weiss, *Jour. Econ. Ent.*, 8, 1915, p. 551.

[3] E. M. Ehrhorn, *Can. Ent.*, 32, 1900, p. 315.

E. O. Essig, *P. C. Jour. Ent.*, 1, 1909, p. 43; 2, 1909, p. 334.

G. F. Ferris, "Cal. Species of Mealy Bugs." *L. Stanford Jr. Univ. Ser. Univ. Ser.* 1918, p. 48.

According to W. S. Hough, this species proves to be the summer form of the clover root mealybug, *Trionymus trifolii* (Forbes) (*Pseudococcus*). *Ent. News*, 33, 1922, p. 171.

[4] G. F. Ferris, *Jour. Econ. Ent.*, 12, 1919, p. 293.

because of the difficulty of reaching the insects and eggs under the shaggy bark. R. L. Nougaret [1] has conducted experiments with sulfur fumigation of grapevines, but this form of treatment has not proven satisfactory.

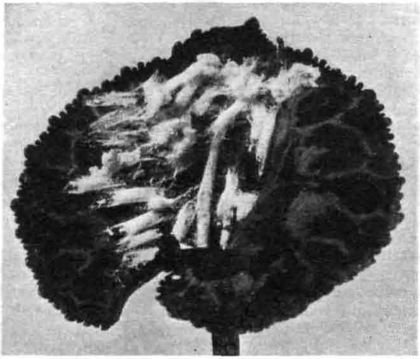

FIG. 168.—Male cocoons of the citrophilus mealybug, *Pseudococcus gahani* Green, on cyclamen leaf.

Miscible and soluble oil and crude carbolic acid emulsion sprays give satisfactory results on fruit and ornamental trees if thoroughly applied.

The palm mealybug, *Pseudococcus nipæ* Maskell (*P. pseudonipæ* Ckll.), is a tropical form occurring in greenhouses, lath houses, and, rarely, in the gardens of Southern California. The brownish or orange yellow bodies are covered with thick plates or lumps of cream-colored, cottony wax. It is found chiefly on palms.

The cypress mealybug, *Pseudococcus ryani* (Coquillet), is covered with white, powdery wax, has short lateral filaments and caudal filaments from one-third to one-half the length of the body. It occurs throughout California on various species of cypress, arborvitæ, Norfolk Island pine, incense cedar, and redwood. It has also been taken on umbrella pine from Japan.[2]

The redwood mealybug, *Pseudococcus sequoiæ* (Coleman), is the common cypress infesting species of California, although it is also common on redwood. It is separated from the preceding species by the very short or wanting anal filaments, and by the presence of the elongated ovisacs. This species has been generally mistaken for *Pseudococcus ryani* (Coq.) already described.

The salt marsh grass mealybugs, *Pseudococcus salinus* (Cockerell) and *P. timberlakei* Cockerell, occur on salt marsh grass. The former is much the commoner throughout the coastal area of California, while the latter appears to be limited to the San Francisco Bay region. Another closely related insect, *Trionymus distichlii* Ferris [3] is often associated with either or both of these species on the leaves or in the axils of salt marsh grass along the Pacific Coast of California. It has a purplish body which is entirely covered with white, cottony wax and 7-jointed antennæ. *Pseudococcus*

[1] *Mthly. Bul.*, Cal. State Dept. Agr. 9, 1920, p. 1.
[2] E. R. Sasscer, *Jour. Econ. Ent.*, 8, 1915, p. 270.
[3] G. F. Ferris, "Calif. Spp. Mealy Bugs." *L. Stanford Jr. Pub. Univ. Ser.* 1918, p. 69.

longisetosus Ferris occurs in the nests of ants and feeds on the roots of thrift, broom-rape, Indian paint brush and poison oak in Central California.

Smith's grass mealybug, *Trionymus smithi* (Essig) (*Ripersia*), is elongated and entirely covered with fine, whitish powder. It inhabits the bases of the leaf blades of wild rye and other grasses of California. *T. festucæ* (Kuwana) is similar in appearance and habits and occurs on wild grasses and on bamboo in the San Francisco Bay region of California. *T. californicus* Ehrhorn feeds on the roots of wild rye in California and Utah.

The woolly oak scale, *Trionymus villosa* (Ehrhorn) (*Ripersia*), has a bright red body, enclosed in a thin, oval, white sac averaging about 4 mm. in length. The young are naked or thinly covered with white, powdery wax and often occur singly at the bases of the opening leaf buds. When clustered in dense colonies they are usually entirely hidden by cottony wax. This species occurs in the cracks and crevices of the bark and in the crotches of the last year's growth of the coast live oak throughout California.

The artemisia scale, *Amonostherium lichtensioides* (Cockerell) (*Erium, Eriococcus artemisiæ* Kuw.), has an almost globular body 2 to 3 mm. in diameter and short, 7-jointed antennæ. The body is entirely enclosed in a large, somewhat globular, felty, creamy-white sac which is conspicuous because of its large size, measuring from 3 to 5 mm. in its greatest diameter. The scales may be single or crowded closely together on the twigs of *Artemisia*, and occurs in California, Nevada, Arizona, New Mexico, Colorado, and Utah.

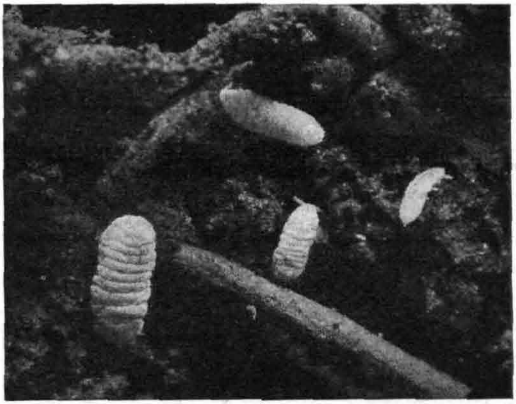

FIG. 169.—The ground mealybug, *Rhizæcus terrestris* (Newstead), as it appears in the soil.

The ground mealybug, *Rhizæcus terrestris* (Newstead) (*Ripersia*) (Fig. 169), is a very small slender species, pale in color, covered with very thin, white, powdery wax. It is a European species reported from the San Francisco Bay region and Southern California and works on the roots of a wide variety of plants, including grasses, acacia, boxwood, chrysanthemum, currant, Shasta daisy, filaree, gooseberry, grape, larkspur, marguerite, orange, peach, pepper, petunia, plum, California privet, thyme, and many weeds.

The mealybugs of the genus *Phenacoccus* are separated superficially from the species of *Pseudococcus* by the presence of the denticle on the inner surface of the claw, and by normally 9-jointed antennæ. In general appearance and habits they are very similar. *Phenacoccus artemisiæ* Ehrhorn commonly infests artemisia in California. From the egg sacs has been reared *Scutellista cyanea* Mots. *P. cevalliæ* Cockerell occurs in New Mexico on cevallia. *P. cockerelli* King infests wild plum in Colorado. *P. colemani* Ehrhorn occurs on wild blackberry, wild strawberry, snowberry, Indian paint brush, and lizard's tail in California and is often taken on grass roots in ants' nests. *P. dearnessi* King (*P. betheli* Ckll.) attacks hawthorn and shad bush or Juneberry in Arizona and Colorado. *P. helianthi* Cockerell infests sunflowers and many other plants in New Mexico, Arizona, and California. *P. minimus* Tinsley inhabits the silver spruce in Colorado. *P. solenopsis* Tinsley feeds on *Kallstræmia brachystylis* Vail and *Bœrhavia specata* Choisy and on the roots of atriplex and other plants in the nests of the fire ant, *Solenopsis geminata* (Fabr.), in New Mexico.

The solanum mealybug, *Phenacoccus solani* Ferris, has generally been considered to be *Pseudococcus solani* Cockerell which occurs on the tubers of potato in New Mexico and roots of nightshade in Colorado, but G. F. Ferris has decided that the species common to California is different and has thus placed it in the former genus.[1] The body is pale yellow and sparsely covered with a fine, white powdery wax. The antennæ are 8-jointed and the lateral and anal filaments are wanting. It infests the roots of aster, malva, nightshade, pansy, pigweed, purslane, wild sunflower, and tomato, and the tubers of the potato.

The yucca mealybug, *Puto yuccæ* (Coquillett) (*Dactylopius, Ceroputo, Phenacoccus ramonæ* Essig), is a large species 7 to 9 mm. long, with pale body entirely covered with thick plates of white, cottony wax. The antennæ are 8- or 9-segmented and there is a distinct denticle on the inner surface of the claw. The host plants include artemisia, aster, banana, black sage, ceanothus, eriophyllum, evening primrose, hedge nettle, ice plant, lantana, lemon, lime, sticky monkey flower, silk tassel bush, and yucca. The roots, crowns, and tops may be infested. The distribution includes California, Arizona, and New Mexico. *P. ambigua* (Fullaway) infests pickle weed in the salt marshes of the San Francisco Bay region. The males are wingless. *P. cupressi* (Coleman) (*Dactylopius, Pseudococcus*) occurs on Monterey Cypress, Monterey pine, California nutmeg, and redwood in the central coast region of California. *P. kœbelei* (Ehrh.) occurs on oak in Arizona. *P. lasiorum* (Ckll.) inhabits ants' nests in Colorado.

The cottony bamboo scale, *Antonina crawi* Cockerell,[2] has a large oval, dark reddish purple body averaging from 3 to 5 mm. in length, and abortive antennæ. The body is entirely enclosed in a thick, compact, white, cottony sac. The scales are often crowded in the leaf axils of the bamboo canes and are very conspicuous and often quite injurious to the host. It is an introduced species from Japan and occurs in Southern California.

TACHARDIINÆ. (Subfamily). Lac Scales.[3] The lac scales get their name from resinous material which encases and completely hides and protects the body, and from which lac or shellac is obtained. The adults are almost globular in form, have rostrum 2-jointed and at anterior end; three tubular projections anteriorly and usually with an additional hornlike dorsal anal projection or spine; antennæ and legs wanting; and always surrounded by the resinous material. The young are free moving. The species producing commercial shellac is *Tachardia lacca* (Kerr) which lives chiefly on *Ficus* spp., in India, Ceylon, Burma, Assam, Siam, China, and the East Indies. There are a number of species native of the arid southwest, all of which produce lac, but not in commercial quantities.

The creosote bush lac scale, *Tachardiella larræ* (Comstock) (*Tachardia*) (Fig. 170), has a nearly globular body 2 mm. in diameter with prominent lac tubes and anal horn. The individuals occur singly or are crowded together in compact masses and completely

[1] "Cal. Spp. of Mealy Bugs." *L. Stanford Jr. Univ. Pub. Univ. Ser.* 1918, p. 60.

[2] E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 132.

[3] J. C. Chamberlin, "A Systematic Mon. of the *Tachardiinæ* or Lac Insects." *Bul. Ent. Research*, 14, 1923, p. 147.

surrounded by a clear, reddish lac. They occur in great abundance on individual creosote bushes and are most frequently found in the area bordering the Colorado River in California and Arizona, but also occur on the Colorado and Mohave Deserts, and in Mexico. The lac was used by the Indians for mending vessels and is considered by some to be in sufficient quantities for commercial purposes. According to T. D. A. Cockerell, it is attended by the small ant, *Cremastogaster atra* Mayr. *T. cornuta* (Cockerell), resembles the above, but has a horn or tooth inclining backwards on the dorsum of the lac covering. Single individuals of the former, however, often have a distinct median tooth on the dorsum. This species is found on *Parthenium incanum* in New Mexico and Mexico. *T. fulgens* (Ckll.) occurs on coursetia, mimosa, and prosopis in Arizona and Mexico. *T. glomerella* (Ckll.) is covered with very dark red lac, and masses on the stems of gutierrezia in New Mexico.

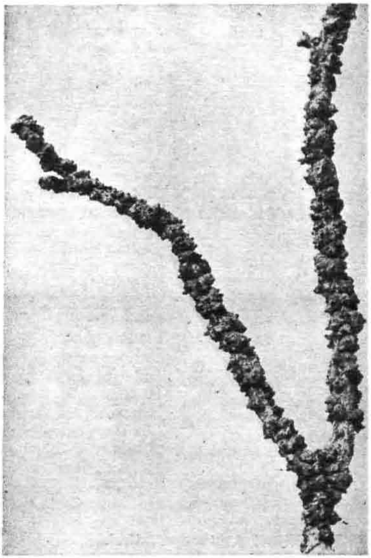

FIG. 170.—The creosote bush lac scale, *Tachardiella larræ* (Comstock), on creosote bush.

COCCINÆ (Subfamily).[1] Soft Scales, Tortoise Scales. The members of this subfamily are oval, flat, elongated or nearly globular, naked, partially or entirely covered with wax, some few of which have an elongated cottony egg sac. The antennæ and legs are usually present, although many species become stationary when fully developed. The males usually undergo transformation beneath a very small, thin, transparent, flat scale. Like the mealybugs, many of the species produce great quantities of honey-

[1] The name *Lecaniinæ* has most often been applied to this subfamily.

dew and much injury and loss to crops is due to the presence of the black smut fungus which grows on this sweet excrement. All of the members normally spend the winter in the half-grown state.

The soft brown scale, *Coccus*[1] *hesperidum* Linn. (Fig. 171), is a very common soft, flat, brown or pale yellow scale, often with brown marbled effect on the dorsum, occurring on a wide variety of greenhouse and ornamental plants, and on shrubs and fruit trees including abutilon, aloe, apple, apricot, aralia, araucaria, ash, avocado, banana, bougainvillæa, box elder, camellia, cassia, citron, clematis, date palm, ferns, facourtia, fig, gardenia, grape, grapefruit, guava, hawthorn, hibiscus, holly, India rubber, English ivy, jasmine, kentia palm, laurel, California laurel, lemon, locust, madrona, magnolia, manzanita, maple, morning glory, mulberry, myrtle, oleander, orange, peach, pear, phlox, pittosporum, plum, poinsettia, poplar, prune, rose, sago palm, sterculia, strawberry tree, water hyacinth, willow, and countless others. It is a cosmopolitan species occurring throughout the world in the tropic and subtropical regions, and in greenhouses in the cooler regions. In the southwest it is common on ornamental plants. In the coastal area of Southern California it is often a pest to young citrus trees up to 4 or 6 years of age, while in Arizona and New Mexico it occurs chiefly on oleander. It produces great quantities of honeydew and is responsible for much smutting of the foliage. There are several broods a year. There are, however, a large number of parasites which virtually control this scale, excepting in rare cases. It is also readily controlled by fumigation and spraying with miscible and soluble oil sprays.

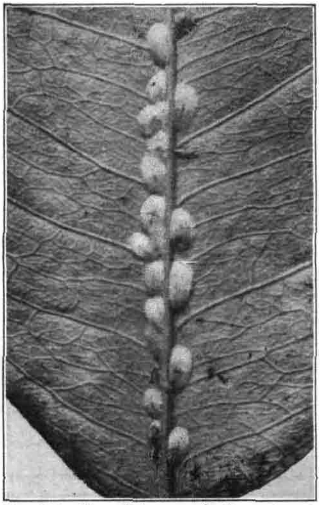

FIG. 171.—The soft brown scale, *Coccus hesperidum* Linn., on orange leaf. Enlarged twice.

The gray citrus or citricola scale, *Coccus pseudomagnoliarum* (Kuwana) (*Lecanium*, *Coccus citricola* Campbell)[2] (Fig. 172), much resembles the soft

[1] A. D. MacGillivray places the members of this genus in *Lecanium*, but the writer is following G. F. Ferris in retaining the old name.

[2] S. I. Kuwana, *P. C. Jour. Ent. and Zoöl.*, 6, 1914, p. 7. Orig. desc.
R. E. Campbell, *Ent. News*, 25, 1914, p. 222.
H. J. Quayle, Bul. 255, Cal. Agr. Exp. Sta. 1915.
E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 140.

brown scale, but is usually larger and has a decidedly mottled gray color when fully mature. The length varies from 5 to 7 mm. This species differs considerably in habits from the preceding species in that it prefers the hot valleys and feeds chiefly on the small limbs of old as well as young trees and is not confined to the tender twigs of young trees of the coastal

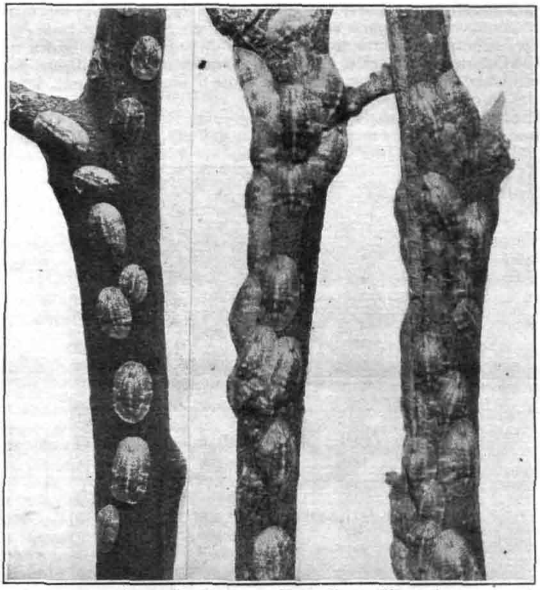

FIG. 172.—The gray citrus scale, *Coccus pseudomagnoliarum* (Kuwana), on orange twigs. Enlarged three times.

region. The young are born alive or from small yellow eggs which hatch almost as soon as laid, and settle on the leaves and small limbs. Maturity is reached in April and May and egg-laying begins about the last of April and continues to the first of July. There is but a single brood annually which is very uneven in some localities. The scales often become so abundant on the twigs as to overlap and form a complete crust over the surface. The quantities of honeydew produced cause smutting of foliage and fruit. This pest was probably introduced from Japan on citrus and was first apprehended in an orange orchard in Southern California by the writer in

1909 and was subsequently described as *C. citricola* by Campbell in 1914. C. P. Clausen has called attention to the fact that it is identical with the citrus-infesting species in Japan and must, therefore, be known as *C. pseudomagnoliarum* (Kuwana) which antedates *C. citricola* Campbell. The species is now established throughout the warmer citrus growing sections of the southern part and the San Joaquin Valley and as far north as San José in California. It is primarily a pest on citrus trees, but has been taken in great numbers on daphne and in small numbers on nightshade by the writer. Control measures are the same as those for the soft brown scale.

The Colorado grass scale, *Eriopeltis coloradensis* Cockerell, has a dark brown body 5 mm. long, enclosed in a white ovisac 10 to 12 mm. long. It occurs on grasses in Colorado.

The fruit tree pulvinaria, *Pulvinaria amygdali* Cockerell, has a flat, oval, yellow or reddish body usually covered with fluffy, white cottony wax and

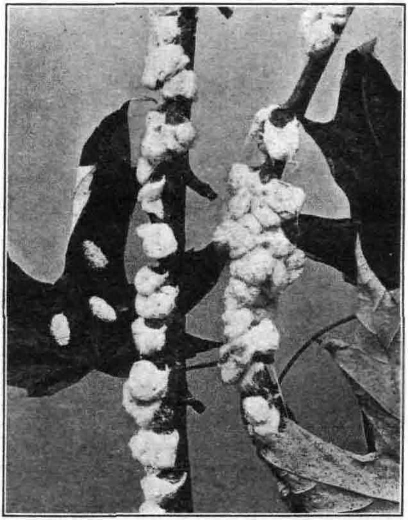

FIG. 173.—The cottony maple or vine scale, *Pulvinaria vitis* (Linn.), on maple. Larvæ of the ladybird beetle, *Hyperaspis signata* (Oliv.), on the leaf at the left. The material for this photo came from Illinois.

a compact, white cottony egg sac at the posterior end, the whole measuring from 10 to 12 mm. The eggs are elongate and pearly white in color. The young scales are oval, flat, naked, yellow or brown much like the soft brown

scale. They become darker as they mature and show a distinct segmentation. The immature forms spend the winter on the twigs and reach maturity in April and May and begin to form the cottony covering and egg sacs. The egg-laying period extends from the middle of April to the middle of June. There is but one brood annually. The scale feeds on the leaves, bark, and fruit of peach, prune, plum, and apple, and the young produce quantities of honeydew, but as yet no serious injury has resulted from the attacks. It occurs in California and New Mexico. *P. coulteri* Cockerell is close to the above and occurs on wild roses in Colorado.

The bigelovia scale, *Pulvinaria bigeloviæ* Cockerell, forms a slender, white, irregular fluted ovisac 5 to 10 mm. long. It occurs on bigelovia or rayless goldenrod in Colorado, New Mexico, Utah, and California.

The camellia scale, *Pulvinaria floccifera* Westwood,[1] has a yellow or pale brown body and long, narrow, white egg sac 5 to 10 mm. long. It is an Asiatic species imported into California and now occurs in greenhouses and ornamental gardens on camellia, calanthe, coffee, euonymus, hydrangea, pittosporum, and many tropical and subtropical plants.

The cottony poison oak scale, *Pulvinaria rhois* Ehrhorn, has a brown body covered with white wax and an ovisac 9 mm. long. It occurs on the leaves and branches of isolated poison oak bushes in Central California.

The cottony maple or vine scale, *Pulvinaria vitis* (Linn.) (*Coccus, C. innumerabilis* Rathvon) (Fig. 173), is the commonest and most widely distributed member of this genus. It occurs throughout Europe and the United States and is reported from practically every Western State. The body is oval or oblong, flat, pale or dark brown, with a large, white cottony egg sac two or three times as long as the body, the length over all being 6 to 8 mm. The preferred food plant is maple but it also infests alder, apple, beech, blackberry, box elder, boxwood, buckeye, currant, elm, euonymus, grape, gooseberry, hackberry, hawthorn, lilac, linden, locust, honey locust, mountain ash, mulberry, oak, orange, osage orange, peach, pear, plum, poplar, quince, rose, sarsaparilla, spiræa, sumach, sycamore, viburnum, willow, and woodbine. *Pulvinaria ehrhorni* King is a California species of much the same appearance as the above species and is commonly mistaken for it. The writer has taken it on alder, maple, quince, and willow.

FIG. 174.—The barnacle scale, *Ceroplastes cirripediformis* Comst., on stem of lemon.

The Japanese or Mexican wax scale, *Ceroplastes ceriferus* (Anderson), is a very interesting cosmopolitan tropical species often taken in quarantine at ports of entry and in greenhouses. The body of the mature female is spherical, black, and about the size of the seed of a sweet pea, but has a prominent horn-like posterior tubercle, and is entirely covered with a thick, white wax appearing much like dough. The outside measurements

[1] E. O. Essig, *Mthly. Bul.*, Cal. State Dept. Agr. 5, 1916, p. 192.

of the individual vary from the very small young to nearly 20 mm. in diameter. The food plants are aralia, camellia, custard apple, coffee, gardenia, hibiscus, lemon, magnolia, orange, persimmon, rubber, and tea.

The barnacle scale, *Ceroplastes cirripediformis* Comstock (Fig. 174), is covered with a white wax beautifully marked in a regular pattern. It is common on citrus, persimmon, quince, and other plants in Florida. Two

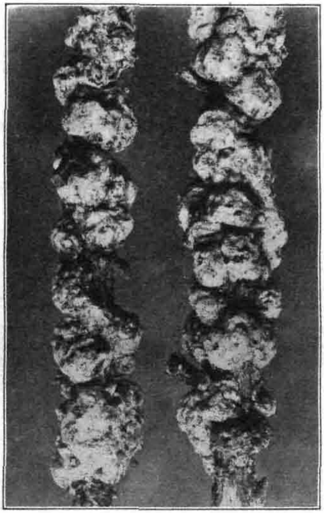

FIG. 175.—The irregular wax scale, *Ceroplastes irregularis* Ckll., on atriplex.

mature specimens were taken on a lemon tree at Ventura, California, in 1920 by C. C. Staunton. G. F. Ferris reports it on lemon at Oxnard, and on the pepper tree at Santa Paula, California. **The Florida wax scale,** *Ceroplastes floridensis* Comstock, is another Florida species frequently taken in quarantine, but not known to be established in the west.

The irregular wax scale, *Ceroplastes irregularis* Cockerell (Fig. 175), is entirely covered with a thick cream-colored wax and usually massed in compact colonies on the branches of various species of *Atriplex*, even extending to the crowns beneath the surface of the ground. The outside diameter of an individual scale is 5 to 8 mm. It occurs in the desert areas of Southern California, Arizona, and New Mexico.

The brown elm scale, *Lecanium canadense* (Cockerell),[1] is 4 to 5 mm. long, dark brown, oval, convex, with very wrinkled surface, which is often slightly pruinose. It occurs throughout the country and in California infests elm, linden, maple, oak, peach, sycamore, and walnut. For control spray with miscible oil or distillate emulsions during the winter.

The calico scale, *Lecanium cerasorum* Cockerell (Fig. 176), is a very pretty species, the mature females being 5 to 7 mm. in diameter, nearly

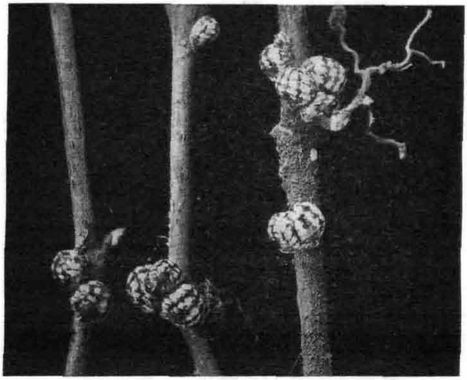

FIG. 176.—The calico scale, *Lecanium cerasorum* Ckll., on Boston ivy.

globular, and dark brown with regular white marks on the dorsum. The whole surface is sometimes covered with a fine wax, but is usually shiny. It is thought to be a Japanese insect which has become established in the San Francisco Bay region of California where it is found on ornamental and fruit trees, including cherry, elm, maple, pear, prune, Boston ivy, Virginia creeper, and English walnut. It is seldom sufficiently abundant to become a pest.

The brown apricot scale, *Lecanium corni* Bouché [2] (Figs. 177, 178), is the commonest and most destructive member of the genus. It assumes a variety of shapes, sizes, and colors and probably includes many other related forms designated as separated species. The typical form is almost hemispherical, being slightly longer than broad, smooth, of a shiny, brown color, varying from 3 to 5 mm. in length. The oval eggs are pearly white, and the young vary from yellow to pale brown in color. The winter is passed in a half-grown condition on the twigs of the last year's growth, maturity being reached in April and May when the eggs occur in great

[1] This species is made a synonym of *L. corni* Bouché by G. F. Ferris: A. D. MacGillivray has placed all the members of this genus in *Eulecanium*.

[2] F. A. Fenton, *Can. Ent.*, 49, 1917, p. 309.

abundance under the scales. Hatching continues from May to July. There is but one brood a year. The females are often so crowded on the under sides of the small limbs as to overlap. The apricot, prune, and pear are the most seriously injured, but the scale also infests alder, apple, ash, basswood, beech, blackberry, box elder, cherry, chestnut, Catalina cherry, currant, elm, gooseberry, greasewood, grape, hawthorn, hazelnut, Cali-

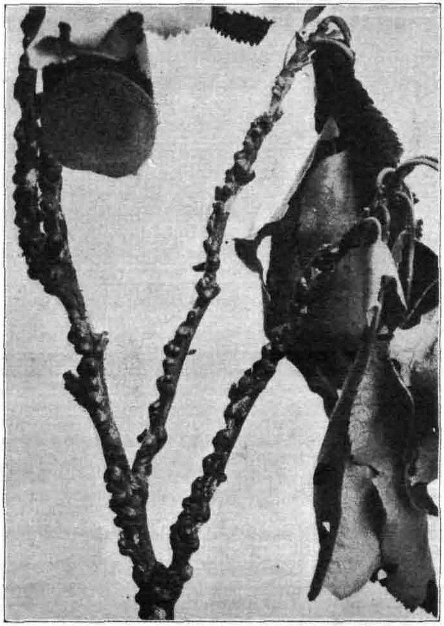

FIG. 177.—The brown apricot scale, *Lecanium corni* Bouché, on apricot.

fornia Christmas berry or mountain holly, locust, magnolia, osage orange, peach, pecan, persimmon, plum, poplar, quince, rose, and willow. The scale is European and is sometimes called the European fruit lecanium. It occurs throughout much of North America and is recorded from the west in California, Oregon, Colorado, and Idaho. It is heavily parasitized, the infected individuals turning black on the dorsum at the time of maturity. The most efficient parasite in the west is *Encyrtus Californicus* (Gir.), which

often makes a complete clean-up of the scale. Control measures [1] consist in the application of any of the standard oil sprays during the winter months.

The excrescent scale, *Lecanium excrescens* Ferris [2] (Fig. 179), is the largest member of this family in the west. It is nearly globular, with often a furrow on top, and measures from 8 to 10 mm. in diameter. The color is

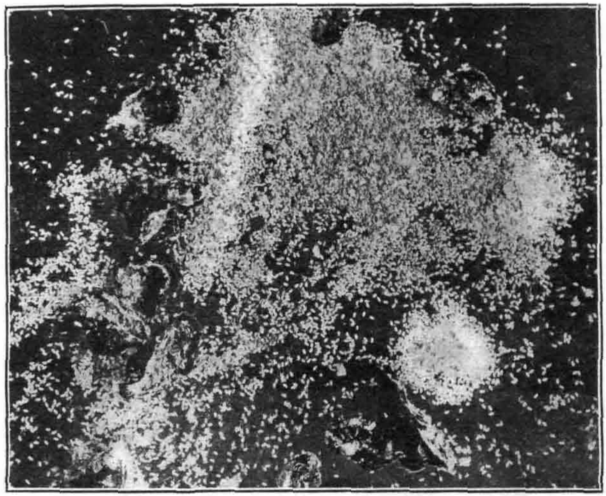

FIG. 178.—Eggs from eight females of the brown apricot scale, *Lecanium corni* Bouché.

brown and living specimens are entirely or partially covered with a white, powdery or fluffy wax, which disappears in the old specimens. It is often associated with *L. cerasorum* Ckll. and in life shows a remarkable resemblance to it in many ways, there appearing to be a noticeable gradation between the two. It occurs often in great numbers on wistaria, but also infests apricot, almond, cherry, pear, peach, elm, sycamore, and walnut. It has probably been introduced from Japan or other Asiatic countries and is at present limited to the San Francisco Bay region of California.

The peach scale, *Lecanium persicæ* (Fabr.) (Fig. 180), greatly resembles the brown apricot scale, but is more elongated, less convex, and often larger, varying from 3 to 6 mm. in length. It occurs on English ivy, ginko,

[1] E. O. Essig, *Circ.* 224, Cal. Agr. Exp. Sta. 1920.
[2] G. F. Ferris, *Stanford Univ. Pub. Biol. Sci.* 1, No. 1, 1920, p. 37.

gooseberry, grape, holly, Japanese flowering quince, mulberry, nectarine, oleander, peach, pear, plum, rose, and silver thorn. The western distribution includes California and New Mexico. It is not a pest.

The frosted scale, *Lecanium pruinosum* Coquillett (Fig. 181), is a large, convex brown scale 8 to 9 mm. long and covered with a frost-like wax. Like *L. canadense* (Ckll.) it is much like *L. corni* Bouché, with which it is often associated on apple, apricot, mountain ash, birch, cherry, elm, grape, hawthorn, laurel, locust, loganberry, osage orange, peach, pear, plum, prune,

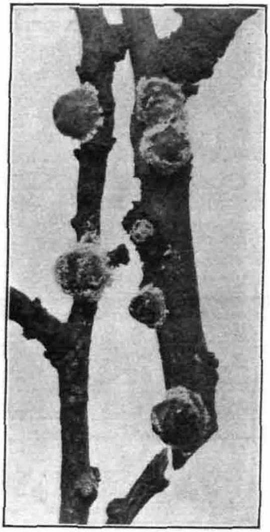

FIG. 179.—The excrescent scale, *Lecanium excrescens* Ferris, on almond.

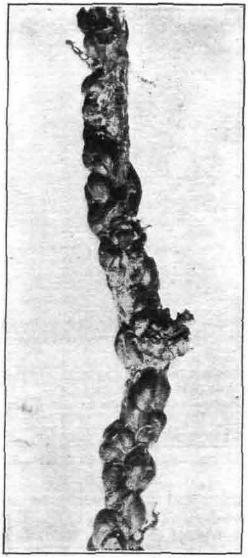

FIG. 180.—The peach scale, *Lecanium persicæ*, (Fabr.) on Boston ivy.

rose, sycamore, and walnut. The distribution of this scale is limited to California and Arizona. It is subject to the same parasitism as the brown apricot scale.

The oak lecanium, *Lecanium quercitronis* Fitch (Fig. 182), greatly resembles the brown apricot scale, but averages a little larger in size. The immature forms usually show a longitudinal median yellow stripe on the dorsum. This species infests the live oak in California and other oaks in Arizona, New Mexico, and Eastern States.

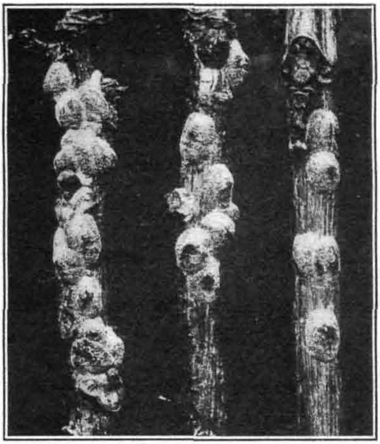

Fig. 181.—The frosted scale, *Lecanium pruinosum* Coq., on English walnut.

Fig. 182.—The oak lecanium, *Lecanium quercitronis* Fitch, on live oak. The thin flat scales on the leaves are those of the males.

The hemispherical scale, *Saissetia hemisphærica* (Targioni) (*Lecanium*) (Fig. 183), is a shining brown hemispherical species 3 mm. in diameter. It is a cosmopolitan tropical species, which is known in greenhouses throughout this country and occurs in the open in various parts of California.

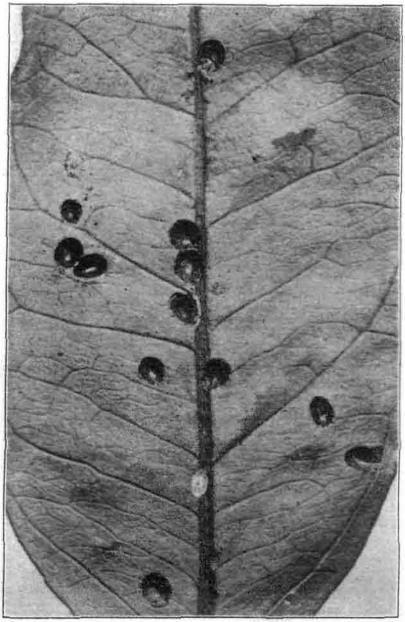

FIG. 183.—The hemispherical scale, *Saissetia hemisphærica* (Targ), on orange leaf.

The hosts include a wide variety of tender plants among which are aloe, asparagus ferns, banana, bignonia, bird's nest fern, camellia, chrysanthemum, citron, croton, custard apple, ferns, grapefruit, guava, lemon, oleander, orange, orchids, palms, sago palm, sour berry sumach, pepper tree, and zamia. Along the coast of Southern California it is often very abundant on the wild sour berry sumach and common but scattered on citrus trees.

The black scale,[1] *Saissetia oleæ* (Bernard) (*Chermes*) [2] (Fig. 184), is by far the most important member of the entire order from an economic viewpoint, being responsible for losses of more than two million dollars annually to fruit growers in California alone. The full grown females are 3 to 5 mm. in

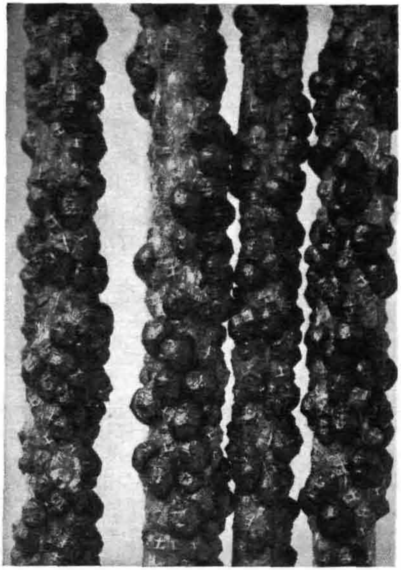

FIG. 184.—The black scale, *Saissetia oleæ* (Bernard), on oleander. Many stages in the development of the female present.

diameter, dark brown or black, nearly hemispherical, hard with two transverse and one longitudinal ridge on the dorsum, forming an obscure or conspicuous letter "H" which is usually more apparent in the young scales than on the adults. The male scales are thin, narrow, flat, semitransparent, and only 2 to 3 mm. long. They usually occur on the twigs and leaves and are not at all common even in heavy infestations of females.

[1] The name black scale outside of California is applied to *Saissetia nigra* (Nietn.), a shining black tropical species which is a serious pest of cotton, hibiscus, rubber, and many other tropical and subtropical plants. It is frequently taken at quarantine at the ports of entry. In Europe *S. oleæ* (Bern.) is known as the olive scale.

[2] H. J. Quayle, Bul. 223, Cal. Agr. Exp. Sta. 1911. Complete account.
E. O. Essig, *Olive Insects of California*. Bul. 283, Cal. Agr. Exp. Sta. 1917, p. 43.

Along the coast of California the black scale has a very uneven hatch so that nearly all stages of development may be found throughout the year, while in the warmer sections away from the coast the hatch is remarkably even and the single annual brood distinct. The winter is normally passed in a half-grown condition and maturity reached in May, June, and July, when egg-laying begins. From 100 to several thousand eggs may be produced by a single female. The young are largely hatched by the middle of August or first of September, when control measures are begun in most citrus sections. On deciduous fruit trees, however, it is necessary to postpone spraying until the trees become dormant and the leaves have largely fallen. This scale is a tropical and subtropical species occurring only in the milder regions of America, and in the west is limited to California, Arizona, and New Mexico, but is of economic importance only in California where it was introduced probably on citrus trees from Florida prior to 1880. As a greenhouse inhabitant it may be found throughout the country. The feeding habits are exceedingly varied and the list of hosts very large, the more important of which are almond, antidesma, apple, apricot, aralia, artemisia, mountain ash, asparagus fern, aster, banana, beech, betel, buckthorn, California mountain holly, California nutmeg, camellia, Deodar cedar, cestrum, chrysanthemum, citron, croton, duranta, eucalyptus, feijoa, fig, fuchsia, grape, grapefruit, grevillea, grewia, groundsel tree, guava, holly, jasmine, Irish juniper, laurel, lemon, locust, honey locust, magnolia, maple, myrtle, nightshade, oleander, olive, orange, orchids, palms, pigeon pea, pear, pepper tree, phlox, pittosporum, plum, pomegranate, poplar, privet, prune, Japanese quince, rose, rose of Sharon, rhubarb, rubber, sumach, sycamore, tangerine, sago palm, strawberry tree, English walnut, watermelon, and many others.

There are many native and introduced natural enemies of this insect. The parasitic fungus, *Isaria* sp.,[1] kills many of the scales under favorable climatic conditions.

The tessellated or palm scale, *Eucalymnatus tessellatus* (Signoret), has much the appearance of the soft brown scale, but is larger, darker brown in color with the surface distinctly marked in mosaic fashion by pale lines. It is a tropical species occurring in greenhouses on betel nut, cinnamon, coconut, coffee, jambas, many kinds of palms, laurel, orchids, seaside grape, water hyacinth.

The irregular pine scale, *Toumeyella pinicola* Ferris, is an irregular yellowish scale 3 mm. long which lives at the bases of the needles of small twigs on the Monterey pine in the San Francisco Bay region, California. It is often associated with the Monterey pine scale but is easily distinguished by the paler color and the wrinkling of dried specimens.

The Monterey pine scale, *Physokermes insignicola* (Craw)[2] (Fig. 185), in the adult stage is a large semi-globular reddish-brown or black, smooth, shiny species, 4 to 6 mm. in diameter, which occurs at the bases of the needles on the tips of the twigs of the Monterey and other pines in California. It produces quantities of honeydew and often seriously injures young trees. *P. coloradensis* Ckll. occurs on spruce and pine in Colorado; *P. concolor* Coleman on fir in California.

The bunch grass scale, *Acerda californica* Ehrhorn, is a very interesting species infesting the stems of bunch grass in the crowns above or below the surface of the ground. The bodies are irregularly globular in shape, amber, red or maroon in color, and 2 to 3 mm. in diameter. They are usually hidden beneath the dry sheaths surrounding the grass stems and may be present in great numbers. This scale occurs on wild rye, *An-*

[1] *Mthly. Bul.*, Cal. State Dept. Agr. 4, 1915, p. 333.
[2] D. Moulton, *Proc. Dav. Acad. Sci.*, 12, 1907, p. 1.

dropogon furcatus Muhl. and other grasses on the hills of the Santa Clara Valley, California. The writer has taken it in great numbers on the slopes of Mt. Hamilton in June. It is also reported in New Mexico. *A. ariditatis* Ferris inhabits the nodes of the stems beneath the bases of the leaves of *Hilaria cenchroides* (?) in New Mexico.

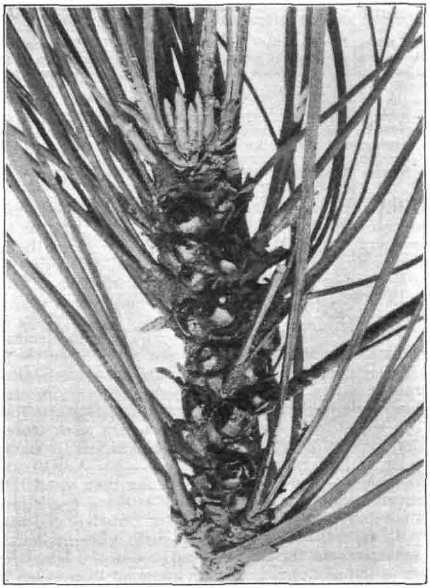

FIG. 185.—The Monterey pine scale, *Physokermes insignicola* (Craw), on Monterey pine.

ASTEROLECANIINÆ (Subfamily). Ceravitreous Coccids. **The pit-making oak scale,** *Asterolecanium variolosum* (Ratzeburg), is an oval, slightly convex, shiny, yellowish green or golden species with faint transverse ridges on the dorsum, and 2 mm. in length. It infests the small limbs and twigs of European oaks, often forming small pits in which the bodies are embedded. It is a European species occurring in many parts of California on oak and olive and elsewhere in the United States. **The soft bamboo scale,** *A. bambusæ* Boisduval, a tropical species, has been taken on bamboo in several places in Southern California.

The oak wax scale, *Cerococcus quercus* Comstock, is one of the most interesting wax scales. The bodies are entirely surrounded with somewhat globular masses of smooth or rough, bright yellow wax, averaging from 4 to 6 mm. in diameter, and often closely crowded in masses surrounding the smaller limbs of oak trees in the semi-arid mountain regions of Southern California and Arizona. The males transform in small elongated sulfur yellow cocoons 3 mm. long, which may be present in great numbers among the young females. Mr. Edw. H. Davis, who sent the writer a quantity of splendid speci-

mens from Mesa Grande, California, writes that the wax was "used from time immemorial by Indians as chewing gum."

Ehrhorn's oak scale, *Mycetococcus ehrhorni* (Ckll.) (*Cerococcus*),[1] is a small bright red pyriform species about 1 mm. long, and covered with a whitish secretion and usually associated with a grayish fungus chiefly on the limbs of the coast live oak. It does, however, also infest the valley and tan oaks. When abundant it may be recognized by the white secretion. The distribution is throughout the San Francisco Bay region, California.

The chamise scale, *Lecaniodiaspis rufescens* (Cockerell) (*Prosopophora*), is distinguished by the somewhat wrinkled, oval, flatly convex, tough, cream or dull brownish sac which encloses the males and females. The mature females are 3 to 4 mm. long, with dark purple body and brown 7- or 8-jointed antennæ. The sacs of the males are much less than half the size of those of the females. The dark red two-winged males are 0.7 mm. long and covered with white powdery wax. This species occurs in widely separated but dense colonies on chamise (*Adenostoma* spp.), *Fouquiera splendens*, cascara, leatherwood, and poison oak in California, Arizona, and New Mexico. *Lecaniodiaspis pruinosa* Hunter is similar in appearance and is recorded from cottonwood and elm trees in Colorado by C. P. Gillette and G. M. List.

DIASPIDINÆ (Subfamily). Armored Scales. The members of this subfamily are characterized by the formation of a thick protective shell or scale above and usually by a very thin layer beneath the body. The scale is formed of wax exuded from wax tubes at the posterior region of the body known as the pygidium. The young are born alive or from eggs and appear much like the scales already described and represent the only motile forms of the members of this large group. They are very minute but active, and crawl considerable distances in search of a suitable feeding place, after which the first molt soon follows, resulting in the loss of legs, antennæ, anal filaments, and so forth, and the assuming of the stationary form consisting chiefly of the mouth parts, the necessary internal systems, and body glands and tubes for the construction of the protective armor or scale. The second molt brings the characteristic elongated, oval, or nearly circular adult form. The body and shell differ considerably in size, shape, and color, and serve as a ready means of separating genera and often species. The male scales are very much smaller than those of the females and often entirely different in shape, usually being much more slender. The color is normally the same in both sexes, but the male scales may be much paler. In general the life history is little different than in the soft, unarmored scales, except the almost total absence of honeydew, the loss of locomotion in the adult, and an often apparent toxic effect on the host plant which may be evidenced by a staining of the tissues as in the case of the San José scale or by a rapid death of the host as in the case of other species, although the latter is common with many of the unarmored scale insects as well. There may be from one to four or even six generations a year, the winter being spent in the egg, immature, or adult stages, or in all three.

The pineapple scale, *Diaspis bromeliæ* (Kern), has a nearly circular, thin, white or light gray scale and orange-yellow body often with purple tints. The male scales are very small, slender, and white. This tropical species commonly occurs on fresh pineapples, and in greenhouses on canna, hibiscus, English ivy, olive, palm, sago palm, and various tropical plants.

The juniper scale, *Diaspis carueli* Targ., has a circular, gray female scale and a minute, narrow white male scale. It infests the cones, twigs, and leaves of arborvitæ, incense

[1] G. F. Ferris, *Can. Ent.*, 50, 1918, p. 330.

cedar, cypress, and juniper, and is a European species distributed throughout the United States, including the west.

The celtis scale, *Pseudodiaspis yuccæ* (Ckll.) (*Diaspis celtidis* Ckll.), has a small, dark gray, circular female scale 1 mm. in diameter with a reddish exuvia, and a narrow gray male scale. It is common on celtis in Texas, occurs on ash, on leaves and fruit of olive in Arizona,[1] and on numerous hosts throughout the southwest.

The cactus scale, *Diaspis echinocacti* (Bouché) (Fig. 186), has a circular, gray female scale with brown exuvia and a slender, white, carinated male scale. It is often so

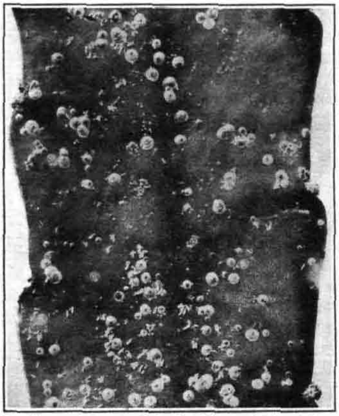

FIG. 186.—The cactus scale, *Diaspis echinocacti* (Bouché), on cactus.

abundant as to completely encrust the surface of many kinds of cacti. It is a common species ranging from South America, through Mexico into Texas, New Mexico, Arizona, and California. G. F. Ferris believes it to be synonymous with *D. calyptroides* Costa, and the variety *cacti* Comst. to be the same.

The manzanita scale, *Diaspis manzanitæ* (Whitney) (*Aulacaspis*), has a large, conspicuous, circular, gray female scale from 1.75 to 2.25 mm. in diameter, and a very small, narrow male scale. It is often present in large numbers on the leaves of manzanita in the Sierra Nevada Mountains of California.

The Italian pear scale, *Diaspis piricola* (Del Guercio) (*Aspidiotus, Epidiaspis*),[2] has a nearly circular, gray female scale with dark brown exuvia, and a slender, white, carinated male scale with yellow exuvia. The bodies are dark reddish purple and serve to readily distinguish the species from related orchard species. It is easily overlooked because it is usually hidden under the lichens, which are readily removed by scraping with a knife blade. Infestations of long duration cause large depressions in the older limbs and may result in materially hastening the death of the tree

[1] A. W. Morrill, *9th Ann. Rept.*, Ariz. Com. Agr. & Hort. 1917, p. 43.

[2] Leroy Childs, "Anatomy of *Epidiaspis piricola* (Del G.)," *Ann. Ent. Soc. Am.*, **7,** 1914, p. 47.

(Fig. 187). This scale has long been known as an orchard-infesting species in the San Francisco Bay region where it attacks apple, currant, mountain holly or California Christmas berry, peach, pear, plum, and prune, and often produces deep pits in young nursery stock. It was first reported by J. H. Comstock in 1883 as *Aspidiotus* (*Diaspis*) *ostreæformis* Curtis,[1] and has often since been mistaken for that species. Control measures [2] are

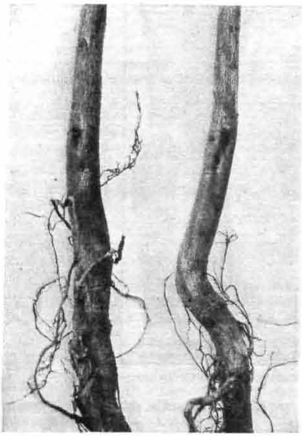

FIG. 187.—Pits on young Myrobalan plum seedlings caused by the Italian pear scale, *Diaspis piricola* (Del Guercio).

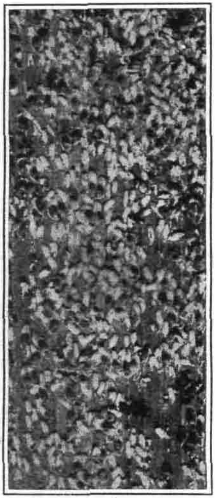

FIG. 188.—The date palm scale, *Parlatoria blanchardi* (Targ.), on leaf of date palm.

most effective in the form of crude oil emulsion sprays to which are added seven pounds of 95 per cent caustic soda to every 200 gallons of spray mixture to remove the lichens which protect the scale.

The date palm scale, *Parlatoria blanchardi* (Targ.)[3] (Fig. 188), has small, elongated, dark gray or almost black female scales with white margins less than 1 mm. in length; and small, slender, white male scales. The female bodies are rose-colored. The scales are often sufficiently abundant to entirely cover the surface of the leaves on which they feed, and cause

[1] *Second Rept.*, Dept. Ent. Cornell Univ. 1883, p. 94.
[2] P. R. Jones, Bul. No. 80, pt. 8, Bur. Ent. U. S. Dept. Agr. 1910, p. 147.
E. O. Essig, *Circ.* 224, Cal. Agr. Exp. Sta. 1920, p. 2.
[3] T. D. A. Cockerell, Bul. 56, Ariz. Agr. Exp. Sta. 1907.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 191.

considerable damage to the commercial date palm which is the chief host, although the Canary date palm is also attached. The pest was introduced into Arizona and California on date plants from Northern Africa and is confined to comparatively small areas in the west by a Federal quarantine. Spraying as suggested for the red date palm scale controls this pest, as does the complete removal and burning of the branches and the flaming of the trunks of the trees by means of a gasoline torch.[1]

The chaff scale, *Parlatoria pergandei* Comstock,[2] has an irregular, nearly circular, dirty gray female scale, 1 mm. in diameter, and smaller, narrow, pale male scales. The female bodies are reddish purple, as are also the eggs and newly hatched young. The species has occasionally been taken on araucaria, camellia, citrus, croton, magnolia, maple, orchids, palms, and various other tropical plants in California.

The purple scale, *Lepidosaphes becki* (Newman)[3] (Fig. 189), has an elongated, oyster-shaped, often slightly curved, brown or purplish female

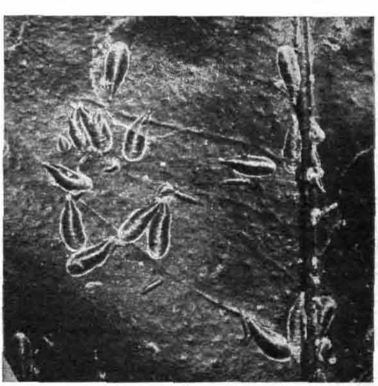

FIG. 189.—The purple scale, *Lepidosaphes becki* (Newman), on orange leaf.

scale, varying from 1.5 to 2.5 mm. in length. The male scales are of the same color, but very narrow and only one-half or two-thirds as long as the females. The minute, elongate-oval eggs are pearly white and occupy most of the shell or scale. The winter is spent in the adult or egg stage, the latter hatching in the spring from May to July. There are several broods during the summer months. This scale is a serious pest of citrus

[1] R. H. Forbes, *Jour. Econ. Ent.*, 6, 1913, p. 415.

[2] Placed in the genus *Syngenaspis* by MacGillivray. G. F. Ferris questions the distinctness of this species from *P. proteus* (Curtis).
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 192.

[3] H. J. Quayle, Bul. No. 226, Cal. Agr. Exp. Sta. 1912.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 186.

trees, infesting all parts including the large limbs, leaves, and fruit, and greatly reduces the vitality or may even kill the host plant. It is a tropical and sub-tropical species introduced into California from Florida in 1888 or 1889 and occurs along the coast of the Southern California citrus district. It does not thrive where the summers are hot. Although the citrus trees are the only ones seriously injured by the purple scale, it is known to occur also on avocado, banksia, Barbados cherry, cercidiphyllum, croton, eucalyptus, fig, murraya, oak, olive, orchids, passion vine, pomaderris, sago palm, silver thorn, hoptree, yew, and many other plants. It has been recorded from greenhouses in many of the Western States. Although there are a number of natural enemies, there is as yet no practical biological control. Artificial control is best accomplished by repeated, heavy fumigations with hydrocyanic acid gas.

FIG. 190.—The oyster shell scale, *Lepidosaphes ulmi* (Linn.), on apple.

Glover's scale, *Lepidosaphes gloveri* (Packard), is another citrus-infesting species somewhat resembling the purple scale, but is readily distinguished by its paler color and the much narrower scales. It is a rare species, having been found only in isolated orchards in San Diego and Orange counties, California. Like the purple scale it is a tropical species which is a serious pest to coconut trees in the South Sea Islands [1] and also infests croton, mango, and magnolia.

The Mediterranean fig scale, *Lepidosaphes ficus* (Signoret),[2] has a small, gray or brown, oyster-shaped female scale and rather conspicuous, light-colored young scales. The species is European and was introduced into Fresno County, California, about 1904–1906 on fig trees or cuttings. It infests chiefly the limbs, but also occurs in great numbers on the leaves and fruit of various species of cultivated and capri figs. The distribution in California is limited to a very small area. Crude oil emulsion applied as a dormant spray gives very good control.

The oyster shell scale, *Lepidosaphes ulmi* (Linn.)[3] (Fig. 190), as the common name implies, looks like a miniature oyster encrusted on a small limb or twig of the host plant. The female scales are light to very dark brown, shining, with many parallel cross ridges, and from 1.5 to nearly 3 mm. in length. The male scales are of the same color and smaller. The eggs are oval and pearly white, there being from 40 to 100 under each scale. The

[1] R. W. Doane, *Can. Ent.*, 41, 1909, p. 299.
[2] F. P. Roullard, *Mthly. Bul.*, Cal. State Dept. Agr. 6, 1917, p. 246.
[3] A. L. Quaintance, *Circ.* No. 121, Bur. Ent. U. S. Dept. Agr. 1910.

winter is largely passed in the egg stage and the young begin to appear in May and June, there being but a single brood annually. The scale is primarily a bark feeder but individuals may occasionally be taken on the fruit and leaves. It commonly occurs on apple, but attacks a large number of other plants including alder, almond, American aspen, false indigo (*Amorpha*), crab apple, apricot, arrow wood, ash, balm of Gilead, basswood, beech, bilberry, white birch, river birch, bittersweet, blackthorn, bladder nut, boxwood, box elder, broom, buckeye, buckthorn, butternut, camellia, camphor, cherry, chestnut, *Clematis paniculata*, coconut, cotoneaster, cranberry, black currant, red currant, dogwood, elm, water elm, false bittersweet, fig, filbert, fir (*Abies firma*), ginseng, gooseberry, goats beard, grape, hackberry, hawthorn, heath, heather, holly, honeysuckle, hop-tree, horse-chestnut, *Horena dulcis*, Juneberry, leatherleaf, leatherwood, lilac, lime, linden, locust, water locust, maple, mespil, American mountain ash, European mountain ash, mountain holly, myrtle, nectarine, New Jersey tea, oak, orchid, *Pachysandra terminalis*, peach, pear, peony, pepper grass, plum, poplar, quince, raspberry, rock-rose, rose, sassafras, senna, silver thorn, spiræa, sycamore, tallow tree, tamarisk, tree of Heaven, tulip tree, *Magnolia tripitala*, viburnum, Virginia creeper, willow, English walnut, and yucca. In California it occurs abundantly only on isolated, neglected trees and has never been an orchard pest. The species is European, and is known in practically every State of the Union. In the west it is recorded in British Columbia, Washington, Oregon, Idaho, Montana, California, Nevada, Utah, Colorado, and probably occurs in all of the others. It is best controlled by dormant crude oil emulsion spray.

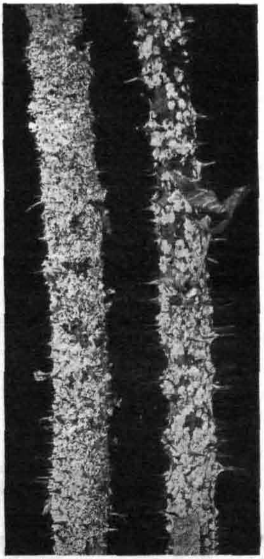

FIG. 191.—The rose scale, *Aulacaspis rosæ* (Bouché), on blackberry.

Two other species of *Lepidosaphes* on native shrubbery often taken about orchards are *L. ceanothi* Ferris which has a whitish scale and infests ceanothus in California, and *L. concolor* (Ckll.) a pale or greenish scale on atriplex in California, Arizona, New Mexico, and Texas.

The rose scale, *Aulacaspis rosæ* (Bouché) (Fig. 191), is a conspicuous species with nearly circular, pure white or light gray female scales, 1 mm. in diameter, and minute, narrow, white, tricarinated male scales. The bodies of both sexes are orange, pink, or dark red, and the small, oval eggs

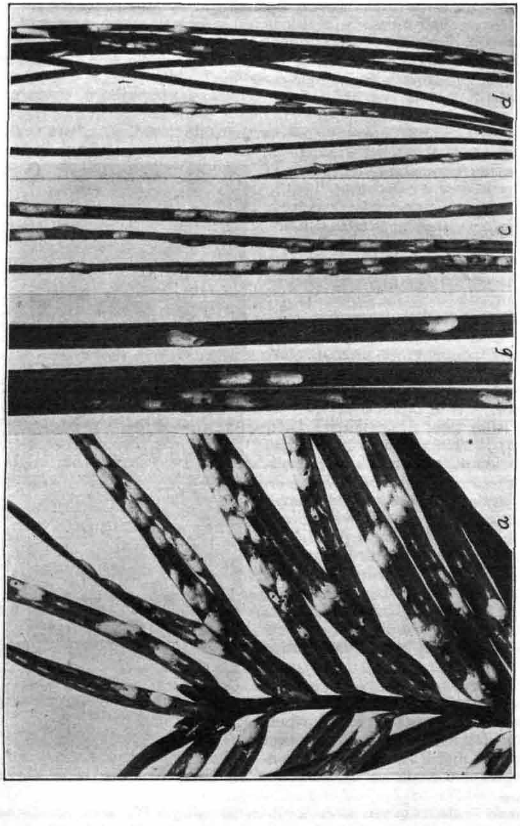

FIG. 192.—The pine leaf scale, *Chionaspis pinifoliæ* (Fitch); *a*, on mountain nutmeg; *b*, on Monterey pine; *c*, and *d*, on yellow pine.

are orange yellow. The scales often occur in such numbers as to completely cover the entire surface of the canes of roses, blackberries, loganberries, and raspberries near the ground, causing them to appear as if whitewashed. This species also infests dewberry, strawberry, thimbleberry, and related plants. The reports of its occurrence on pear, mango, palms, and so forth, have probably confused it with other species. The distribution is cosmopolitan and includes much of the United States. In the west it is known

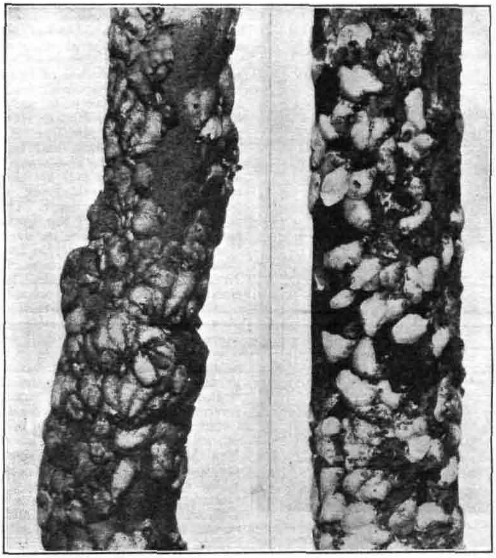

FIG. 193.—The black willow scale, *Chionaspis salicis-nigræ* (Walsh), on poplar and maple.

in British Columbia, Washington, Oregon, California, Arizona, Colorado, and probably occurs wherever the hosts are extensively cultivated. Dormant miscible oil or distillate oil emulsion sprays give very satisfactory control. Pruning out the infested canes ordinarily suffices for blackberries, loganberries, and raspberries, except where the canes are left for several years.

The West Indian peach scale, *Aulacaspis pentagona* (Targ.), is a very serious pest to deciduous fruit trees and sub-tropical plants, but has rarely been taken in the west. It is not yet established in our region.

The genus *Chionaspis* contains a number of interesting species which have pure white or gray, pyriform or oyster-shaped female scales, from 1 to 2 mm. long, and minute, narrow, often ribbed, white male scales, both sexes usually having yellow exuviæ. **The euonymus scale,** *C. euonymi* Comstock, has a nearly black female and a snowy white male scale. It is occasionally taken on euonymus in greenhouses in various parts of the country. **The scurfy scale,** *C. furfura* (Fitch), is a pest of deciduous fruit trees and ornamental trees and shrubs in the Eastern States. It is recorded in Idaho, Utah, and Colorado,[1] and wrongly reported from California. **Lintner's scale,** *C. lintneri* Comstock, occurs in Colorado and California and infests alder, arrow wood, spice bush, ceanothus, white birch, dogwood, hazelnut, Juneberry, and leatherwood. **The cottonwood scale,** *C. ortholobis* Comstock, is a common western species in Colorado, New Mexico, and California, on willow and cottonwood, but also occurs on butternut, honey locust, and poplars. The male scales are carinated, thus differing from related species. **The pine leaf scale,** *C. pinifoliæ* (Fitch) (Fig. 192), is the commonest and best known member of the genus. The female and male scales are pure white and are sharply contrasted with the dark green coniferous needles on which they occur. This species is abundant throughout the United States and Canada, and occurs in most of the Western States, being reported from British Columbia, Washington, Oregon, California, Nevada, Idaho, and Colorado. It often occurs in the forests in great numbers on nearly all species of pine, particularly yellow, digger, sugar, white, lodgepole, Monterey, Torrey, red, Scotch, Soledad, stone, and other pines. Douglas fir, white fir, California nutmeg, incense cedar, and spruce are also infested. Oil sprays give satisfactory control on ornamentals. **The oak scale,** *C. quercus* Comstock, is common on the California live, maul, tan, white, valley, and other oaks in California. It also occurs in New Mexico. **The black willow scale,** *C. salicis-nigræ* (Walsh) (Fig. 193), is a bright, white species often exceedingly abundant around the bases of ceanothus bushes in California, and on the limbs and twigs of cascara sagrada in British Columbia, Washington, and Oregon. It also occurs in Colorado, New Mexico, Arizona, and throughout the east, infesting dogwood, maple, poplar, shad bush, tulip tree, and willow. **Sasscer's scale,** *C. sassceri* Ckll. and Robbins, has been taken on orange in San Diego County and on tamarisk in Indio County, California. **The cord grass scale,** *C. spartinæ* Comstock (Fig. 194), has snow white scales and is often very abundant on cord or salt marsh grass around the salt marshes of the San Francisco Bay region, California. **The wistaria scale,** *C. wistariæ* Cooley, has frequently been taken by the writer on wistaria plants in Central and Southern California. It apparently has come with the plants from Japan.

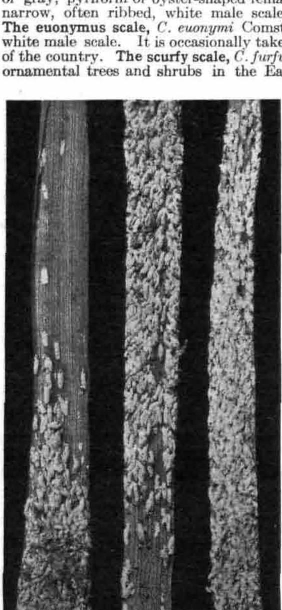

FIG. 194.—The cord grass scale, *Chionaspis spartinæ* Comstock, on cord grass or salt marsh grass.

The aspidistra scale, *Pinnaspis aspidistræ* (Signoret) (*Hemichionaspis*), is a common house and greenhouse pest of aspidistra and ferns. The female scales are oyster-shaped and brown and somewhat resemble those of the purple scale, while the male

[1] A. L. Quaintance, *Circ.* 121, Bur. Ent. U. S. Dept. Agr. 1910.
Bul. 87, Idaho Agr. Exp. Sta. 1916.

scales are minute, pure white, and tricarinated. This is a tropical species and a pest to the coconut in the Society Islands,[1] and is found in many greenhouses and residences throughout the country, infesting also acacia, areca nut, banana, betel nut, fig, mango, orange, orchids, palms, pepper tree, and so forth. Infested potted plants are cleaned by dipping in a miscible oil solution. A related species, *P. minor* (Mask.), is a very serious pest to cotton in Peru.[2]

The grass root scale, *Odonaspis graminis* Bremner, appears like a dirty white, miniature clam on the roots of grasses in the San Francisco Bay region, California.

The large genus *Aspidiotus* is undergoing so many changes that it is difficult to present a satisfactory nomenclature and, therefore, the author is adhering to the more general uses of the name. Many species are pests of prime consideration, while the majority are of no real importance. For control measures see the San José scale. The less important members are listed first. **The buckeye scale,** *Aspidiotus æsculi* Johnson, has a large,

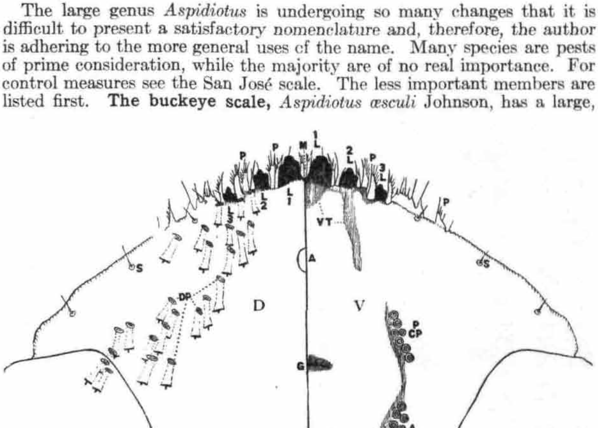

FIG. 195.—The pygidium of the ivy scale, *Aspidiotus hederæ* (Vallot). D, dorsal side; V, ventral side; A, anal opening; G, genital opening; 1L, first pair of lobes; 2L, second pair of lobes; 3L, third pair of lobes; M, median notch; P, pectinæ; DP, dorsal pores; ACP, anterior circumgenital pores; PCP, posterior circumgential pores; S, spines; VT, ventral thickenings.

yellowish gray, almost circular, female scale, about 2 mm. in diameter. It is often present in large numbers on California buckeye, box elder, bur oak, linden, pear, poplar, and willow in California, Utah, and New Mexico, and is sometimes responsible for a pitting of the bark. **Putnam's scale,** *A. ancylus* (Putnam), has blackish brown scales, 1 to 2 mm. in diameter, and is a common North American species, occurring in Washington, Colorado,

[1] R. W. Doane, *Jour. Econ. Ent.*, 2, 1909, p. 220., *Can. Ent.*, 41, 1909, p. 297.
[2] C. H. T. Townsend, *Jour. Econ. Ent.*, 5, 1912, p. 256.
E. W. Rust, *Jour. Econ. Ent.*, 7, 1914, p. 470.

and New Mexico in the west.[1] It is often an orchard pest on apple, peach, pear, and plum, but also infests apricot, ash, beech, bladder nut, box elder, cherry, cottonwood, cranberry, currant, elm, hackberry, hemlock, linden, honey locust, water locust, maple, oak, osage orange, and quince. *A. candidulus* Cockerell infests prosopis in Arizona. *A. coniferarum* Ckll. is often abundant on the bark of incense cedar and cypress in California,

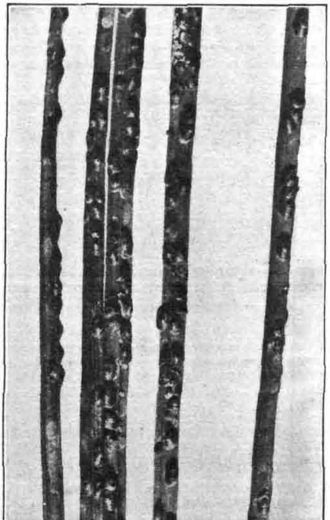

FIG. 196.—The hemlock scale, *Aspidiotus pini* Comstock, on needles of yellow pine.

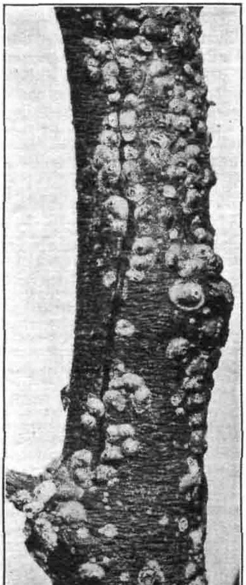

FIG. 197.—The greedy scale, *Aspidiotus camelliæ* Sign., on acacia.

and yellow pine in New Mexico. **The tan oak scale,** *A. densifloræ* Bremner, occurs on the undersides of the leaves of tan oak and valley, live, and maul oaks in California. *A. ehrhorni* Coleman infests the bark of Douglas fir in California. **The cherry scale,** *A. forbesi* Johnson, is a common orchard scale in the Eastern and Middle States on deciduous fruit and ornamental trees. C. P. Gillette[2] reports it on hard-tack, *Cercocarpus parvifolius*

[1] The report of its occurrence in California cannot be verified.
[2] Bul. 94, Colo. Agr. Exp. Sta. 1904, p. 15.

Nutt., in Colorado. *A. osborni* Ckll. (*A. yulupæ* Bremner) occurs on the bark of coast live and valley oak in California. **The pear tree oyster scale,** *Aspidiotus ostreæformis* Curtis, is a common species on deciduous fruit and ornamental trees in Europe and the eastern part of the United States. It is recorded on apple in British Columbia, Idaho, and California. In California *Diaspis piricola* (Del G.) has generally been misidentified as this species. One record by Geo. A. Coleman in 1914 lists it from Latonville, California. **The hemlock scale,** *Aspidiotus pini* Comstock (*A. abietis* Comst., *A. californicus* Coleman)[1] (Fig. 196), is a native western species with almost circular, nearly black scales, occurring in great numbers on the needles of Douglas fir, hemlock, and digger, Monterey, yellow, and knobcone pines. It is generally distributed throughout North America and is known in British Columbia and California in the west. It has been observed to kill young pine trees in California. **The grape scale,** *A. uvæ* Comstock (Fig. 200), infests the canes of the American varieties of grape in the San Francisco Bay region of California.

The greedy scale, *Aspidiotus camelliæ* Sign. (*A. rapax* Comst.)[2] (Figs. 197, 198), is the commonest and most widely distributed species of the armored scales in California. The scales are thin, light gray, very convex, and noticeably pointed, with the yellow or dark brown exuviæ near one edge. The diameter of the female scale averages 1.2 mm. The male scale is of the same color, but much smaller and more elongated. The female body is circular or somewhat pyriform, bright yellow, and has but one pair of lobes on the pygidium. This scale is an omnivorous feeder, infesting chiefly the bark, but also frequently occurs on the leaves and fruit. Among the common food plants are acacia, almond, apple, avocado, bladder pod, boxwood, broom, buck brush or ceanothus, camellia, camphor, cestrum, chapparal broom, cherry, cissus, cotoneasters, cottonwood, English holly, English ivy, English laurel, eucalyptus, euonymus, fig, fuchsia, genista, giant sequoia, grape, hakea, heath, mountain holly, Japanese quince, California laurel, lavatera, locust, magnolia, manzanita, mistletoe, myrtle, nightshade, olive, orange, Oregon grape, palms, passion vine, pear, pepper tree, pittosporum, pomegranate, pyracantha, quince, red bud, sage, rose, sedum, strawberry tree, strelitzia, tan oak, umbrella tree, English walnut, willow, and yam. It is a European species occurring throughout North America, but mostly in greenhouses. In the west it is recorded out-of-doors from California, Oregon, Arizona, New Mexico, and Colorado (greenhouses).

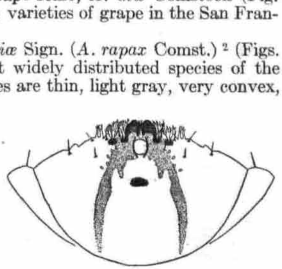

FIG. 198.—Pygidium of the greedy scale, *Aspidiotus camelliæ* Sign.

The ivy or oleander scale, *Aspidiotus hederæ* (Vallot) (Figs. 195, 199), very much resembles the greedy scale in the general appearance of the shells

[1] G. F. Ferris, "Scale Ins. Santa Cruz Pen.," *Stanford Univ. Pub. Univ. Ser. Biol. Sci.*, 1, No. 1, 1920, p. 52.

[2] This species is placed in the genus *Hemiberlesia* by many European and American writers.

E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 175.

which, however, are very much flatter, paler in color, and with the exuviæ central. The female body is pale yellow and has three pairs of lobes on the

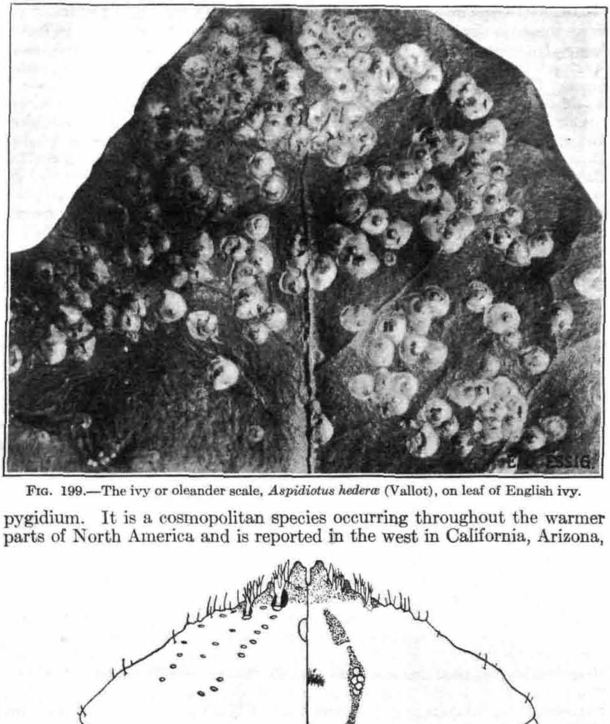

FIG. 199.—The ivy or oleander scale, *Aspidiotus hederæ* (Vallot), on leaf of English ivy.

pygidium. It is a cosmopolitan species occurring throughout the warmer parts of North America and is reported in the west in California, Arizona,

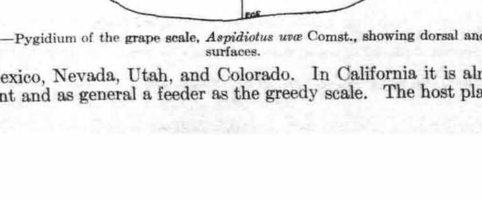

FIG. 200.—Pygidium of the grape scale, *Aspidiotus uvæ* Comst., showing dorsal and ventral surfaces.

New Mexico, Nevada, Utah, and Colorado. In California it is almost as abundant and as general a feeder as the greedy scale. The host plants are

many consisting of acacia, aloe, asparagus ferns, avocado, azalea, banana, betel nut, boxwood, buckthorn, broom, cactus, California laurel, camellia, carob, carpodetus, cherry, citron, clover, coconut, currant, daphne, eucalyptus, ferns, genista, grape, grapefruit, grasses, guava, hakea, heath, holly, English ivy, lemon, madder, magnolia, manzanita, maple, mistletoe, Monterey pine, mulberry, myrsine, myrtle, nightshade, olive, holly oak, orchids, orange, oxalis, palms, pepper tree, poinsettia, pomegranate, potato, red bud, redwood, rubber, sago palm, sumach, umbrella plant, umbrella tree, vitex, yew, and yucca. It is somewhat of a pest to olives in California, attacking the leaves and fruit, causing a discoloration of the latter when ripe, and also occurs on olives in Arizona. It also infests the fruit of lemons and oranges, rarely causing deformation. Control measures are the same as for the San José scale. On olive trees [1] the oil sprays should be used from one-half to three-quarters dormant strength as recommended for deciduous fruit trees.

Howard's scale, *Aspidiotus howardi* Cockerell,[2] has a circular, flat, pale gray female scale with a reddish thinge and subcentral exuvia. The body is orange and has three pairs of lobes. It is a Rocky Mountain species occurring chiefly at high altitudes in Colorado and New Mexico, on deciduous fruit and ornamental trees including almond, apple, ash, peach, pear, wild and cultivated plum, and prune. The pear is the preferred host although the plum and prune are also favored. The insect has a tendency to infest the fruits causing pitting and a reddish stain like the San José scale, with which it is likely to be confused. Control measures are the same as for the San José scale.

The walnut scale, *Aspidiotus juglans-regiæ* Comstock, has a very large, flat, nearly circular, pale gray or yellowish female scale, 2 mm. in diameter and with central exuvia. The female bodies are yellow mottled orange. This scale occurs in Europe, in a number of the Eastern States, and in New Mexico, Colorado, Nevada, California, and Oregon in the west. It infests chiefly cottonwood, but also attacks apple, apricot, ash, box elder, cherry, currant, elm, grape, linden, locust, maple, peach, pear, plum, prune, rose, and English walnut. It may kill individual limbs, but is not a serious pest.

The San José scale,[3] *Aspidiotus perniciosus* Comstock [4] (Figs. 201, 202, 203), is probably the most famous member of the family of scale insects because of its widespread and serious attacks on deciduous fruit trees throughout the country. It is thought to be a native of China and now has almost a world-wide distribution. It is supposed to have been brought into California about 1870 on some flowering peach trees imported from China into the Santa Clara Valley by James Lick. The female scales are nearly circular, slightly convex, almost black when small and becoming

[1] E. O. Essig, *Olive Insects of California.* Bul. 283, Cal. Agr. Exp. Sta. 1917, p. 50.
[2] E. P. Taylor, Bul. 120, Colo. Agr. Exp. Sta. 1907. Also Bul. 67, Bur. Ent., U. S. Dept. Agr. 1907, p. 87.
[3] The scale has also been called the Chinese and pernicious scale, but only the above name satisfies. MacGillivray places it in a new genus, *Comstockaspis.*
[4] Practically every Agricultural Experiment Station in the United States has issued one or many bulletins on this pest. A few of the more important publications are: J. H. Comstock, *Rept.* U. S. Dept. Agr. 1880, p. 300 (1881). Orig. desc. C. L. Marlatt. Bul. 62, Bur. Ent., U. S. Dept. Agr. 1906.

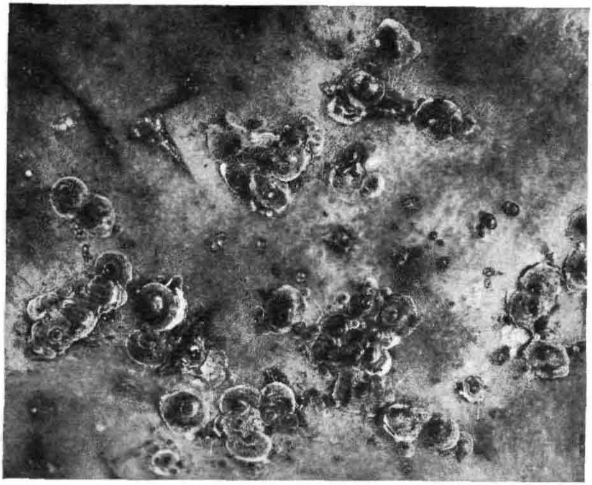

FIG. 201.—The San José scale, *Aspidiotus perniciosus* Comstock, on apple. Greatly enlarged.

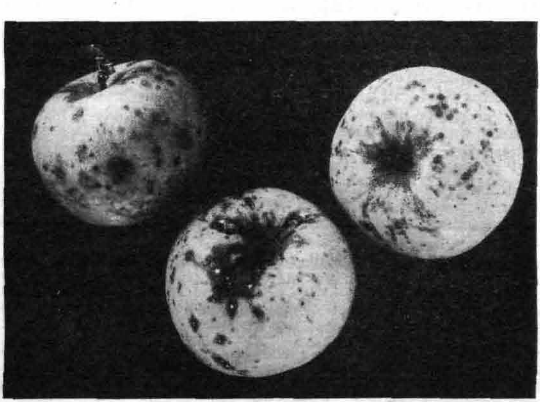

FIG. 202.—Apples showing stains, which are reddish, due to the presence of the San José scale, *Aspidiotus perniciosus* Comstock.

gray when fully developed with central yellow or orange exuviæ. The bodies are bright yellow with two pairs of lobes. The male scales are of the same color but narrower and smaller than the females. The adult males are minute, pink, two-winged insects. This scale occurs in practically every State in the Union and in many is still the most injurious orchard pest. In some of the Western States it is also a pest of major importance. Strangely enough, in California it is now seldom if ever met with in the commercial orchards, though occasionally it is taken in great numbers on isolated trees in orchards, but more often on neglected trees in towns and cities. One of the serious things about the pest is the large number of food plants which make control measures quite difficult. In the long list of hosts are found the following which serve as an indication of its omnivorous feeding habits: acacia, actinidia, akebia, alder, almond, apple, apricot, arborvitæ, ash, mountain ash, beech, birch, false bittersweet, blackberry, buttonbush, buckthorn, catalpa, ceanothus, cherry, sand cherry, chestnut,

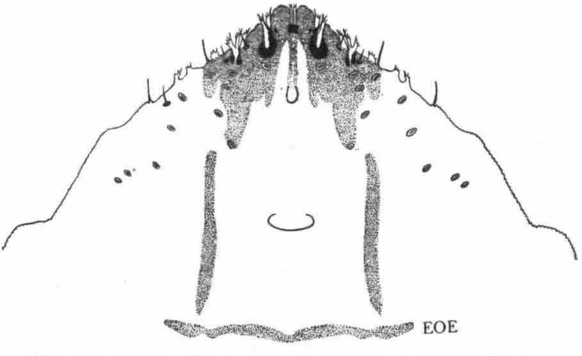

FIG. 203.—Pygidium of the San José scale, *Aspidiotus perniciosus* Comstock.

chokeberry, cotoneaster, currant, dogwood, elder, elm, eucalyptus, euonymus, fig, gooseberry, grape, hackberry, hawthorn, hibiscus, honeysuckle, locust, loquat, maple, milkweed, mulberry, orange, osage orange, peach, pear, sand pear, pecan, persimmon, photinia, plum, poplar, privet, prune, quince, Japanese flowering quince, raspberry, rose, sassafras, shad bush, silver thorn, smoke bush, snowball, snowberry, spiræa, sour gum, strawberry, sumach, Virginia creeper, English walnut, black walnut, and willow. Control measures for this pest as first worked out in California consisted in applications of the lime-sulfur-salt mixture which was "formerly used as a sheep dip in Australia and employed in California with little change." This spray became known as the California wash [1] and was applied during

[1] It has also been called the Oregon Wash. A. B. Cordley, Bul. 88, Ore. Agr. Exp. Sta. 1906.

the dormant period in winter. It gave successful control, but it was soon learned that the salt was seriously injuring the trees so that it was omitted and lime-sulfur became the standard spray for the control of this scale, and still is used in many States. Liquid lime-sulfur, 1 to 9, and the dry material of equal strength, is a very satisfactory spray for the scale and is generally used throughout the world. In the west the crude oil emulsion and other oil sprays are being used, except in such cases where a fungicide is specially desired. Lime-sulfur injury, however, often makes it advisable to use the oil sprays and Bordeaux mixture combined or as separate sprays instead, particularly on peaches and apricots.

The red scale, *Chrysomphalus aurantii* (Maskell) [1] (Fig. 204), has a thin, circular, convex female scale from 1 to 2 mm. in diameter and with central

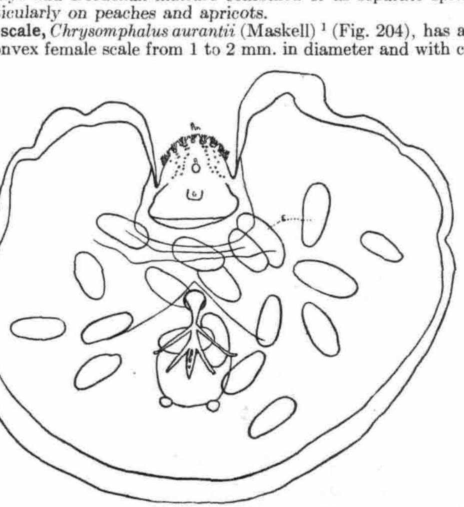

FIG. 204.—The red scale, *Chrysomphalus aurantii* (Mask.). Female body removed from the scale. An, pygidium; A, anal opening; G, genital opening; E, eggs within body.

exuvia. The mature female bodies are nearly circular, 1 x 0.78 mm. in dimensions and of a bright reddish color showing through the scale, giving rise to the common name. The pygidium of the mature female has the appearance of having been pushed into the posterior end of the body so that the tip is a little beyond the line marking the circumference of the body. There are three pairs of lobes and many finely divided plates or pectinæ. The male scale is elongated and much smaller than the female. This scale is a tropical and subtropical species introduced into California prior to 1880 from Australia. China is supposed to be the native region. It occurs

[1] This scale is also known as the California red scale and orange scale.
H. J. Quayle, *The Red or Orange Scale.* Bul. 222, Cal. Agr. Exp. Sta. 1911.

in greenhouses in many parts of the country but is known outside only in the Southern States and in Southern California. In the latter the distribution is limited almost entirely to the milder coast regions. It is primarily a pest to various citrus trees including citron, grapefruit, lemon, orange, tangerine, trifoliate orange, and so on, but also infests acacia, aloe, apple, aspidistra, breadfruit, banana, box elder, boxwood, coconut, coprosma, eucalyptus, euonymus, fig, fuchsia, goldenrod, grape, holly, mango, bur marigold, mulberry, nightshade, oak, olive, palm, passion vine, pear, pistacia, podocarpus, privet, quince, rose, sago palm, sweet bay, tea, English walnut, and willow. All parts of the plants are attacked including limbs twigs, leaves, and bark, and in many cases the hosts are killed outright by its work. **The yellow scale,** *C. citrinus* (Coquillett), is considered as a

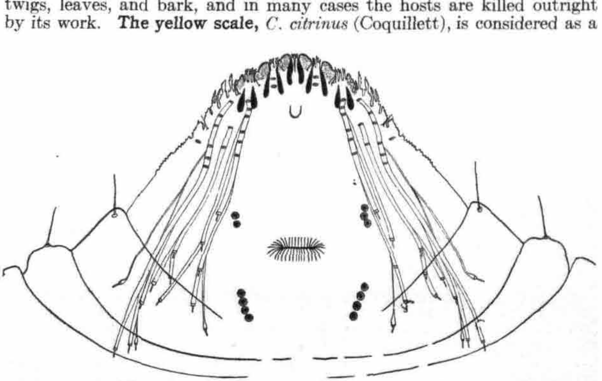

FIG. 205.—Pygidium of the dictyospermum scale, *Chrysomphalus dictyospermi* (Morgan).

variety of the red scale, there being no anatomical reason for separating the two. The latter, however, is distinctly yellow in color and differs much in habits, in that it prefers the warmer regions of California and is more commonly met with in the interior citrus-growing regions of the northern, southern, and central parts of the State, although it may overlap the same areas inhabited by the red scale. It differs also in the fact that it feeds only on the leaves and fruit, and rarely, if ever, on the twigs and larger limbs. The known host plants of the yellow scale are fewer, consisting of citrus trees, aucuba, daphne, euonymus, wild Japanese ginger, pandanus, palm, India rubber, English ivy, and St. John's wort. The natural enemies of the two forms are practically the same. The most satisfactory control measures consist in repeated, heavy fumigations with HCN.

The Florida red scale, *Chrysomphalus aonidum* (Linn.), is easily distinguished from the preceding species by the dark mahogany red or almost black color of the scales. It is also a tropical and subtropical cosmopolitan species common throughout the country in greenhouses. In Florida it

occurs on citrus trees, but in California it has never become established in the open. The favored food plants in greenhouses are citrus, aspidistra, and palms, but it is also known to infest aralia, araucaria, banana, begonia, camellia, camphor, coconut, eucalyptus, eugenia, fig, grape, guava, jasmine, English ivy, mango, oleander, orchids, rubber, rose, sago palm, and zamia.

The black araucaria scale, *Chrysomphalus rossi* (Maskell), is likely to be confused with the Florida red scale because of the almost black color of the scales. It is a tropical species with a very limited distribution in the ornamental gardens of Southern California where it occurs chiefly on *Araucaria bidwillii* and, rarely, on California redwood. Other hosts are *Araucaria imbricata*, abutilon, artemisia, banksia, coccobolia, copparis, euonymus, grass tree, hyssop, oleander, olive, orchids, palm, rhinocarpus, and sago palm.

The Spanish red or dictyospermum scale, *Chrysomphalus dictyospermi* (Morgan) [1] (Fig. 205), is considered to be the most serious pest to citrus trees in Spain,[2] and is also a citrus pest of major importance throughout

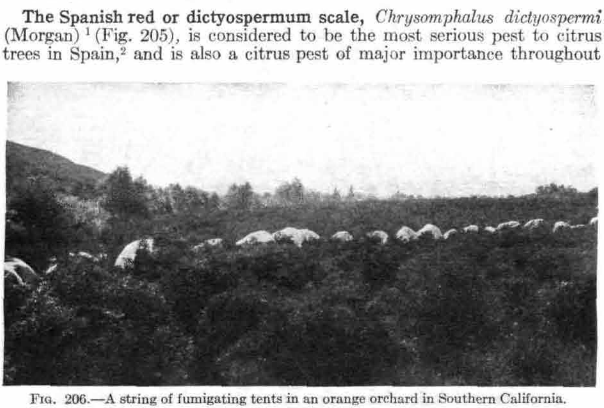

FIG. 206.—A string of fumigating tents in an orange orchard in Southern California.

Southern Europe.[3] Although it has frequently been taken in quarantine and in greenhouses in California, it has never become established in outside ornamental or orchard plantings. It has been taken in great numbers on mango seedlings in a lath house in Southern California. Because of its seriousness, however, it should be known so that any infestations can be apprehended and exterminated before it becomes generally established. The scales are circular, very flat and pale yellowish brown in color, not greatly different from the yellow scale. It infests a long list of host plants, some of the important ones being acacia, almond, avocado, boxwood, all varieties of citrus, euonymus, guava, English ivy, mango, palms, peach,

[1] E. O. Essig, *Mthly. Bul.*, Cal. State Dept. Agr. 5, 1916, p. 195.
G. F. Mozenette, "Insect Enemies of the Avocado." *Farmers' Bul.* 1261, U. S. Dept. Agr. pp. 4–8, 1922.
[2] J. M. Priego, *Mthly. Bul. Agr. Intell. and Plant Dis. Int. Inst. Agr. Rome*, 4, No. 2, 1913, p. 161.
[3] H. J. Quayle, Bul. 134, Bur. Ent. U. S. Dept. Agr. 1914, p. 15.

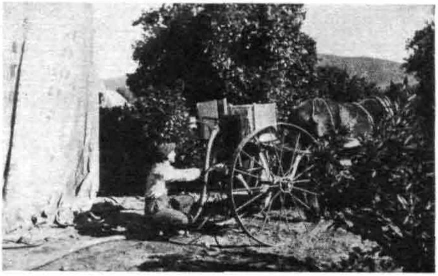

Fig. 207.—A fumigating machine in operation. In this type the HCN is generated in the machine and conducted under the tent by means of a large hose.

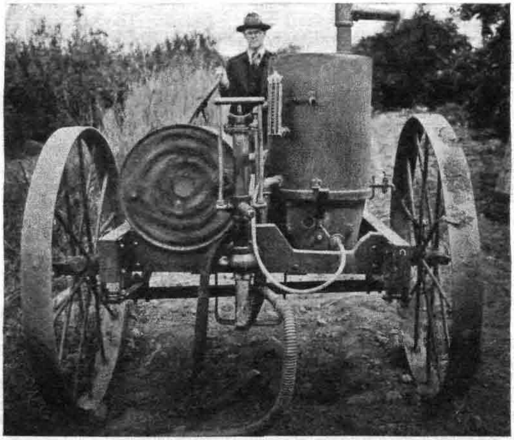

Fig. 208.—A vaporizer in which the liquid HCN is heated before liberated under the fumigating tent. (Photo furnished by H. J. Quayle.)

rose, sago palm, and many subtropical and tropical plants. In Southern Europe parasitic control of this insect is pointed to with much pride, the chief parasites being *Prospaltella lounsburyi* Berlese and Paoli;[1] *Aphelinus silvestrii* Del G., *A. chrysomphali* Merçet; *Aspidiotiphagus citrinus* (Craw); *Aphycus flavus* How.;[2] *Signiphora merceti* Malen.; and *Parvulinus aurantii* Mercet.[2]

The redwood scale, *Aonidia shastæ* (Coleman) (*Aspidiotus coniferarum shastæ* Colm.), has a thin, dirty white, transparent, cone-shaped female scale 1 mm. in diameter which greatly resembles drops of exuded gum of MacNab cypress which it infests. According to G. F. Ferris it also becomes very abundant on the leaves of redwood trees in California.

ALEYRODIDÆ.[3] White Flies, Aleyrodids.

The white flies are very small insects from 1 to 3 mm. long, the adults of which are characterized by having the body and wings covered with a fine, whitish powdery wax giving an opaque appearance. The compound eyes are somewhat reniform and there are but two ocelli, one near the front of each compound eye. The antennæ are well developed and usually seven-segmented; the rostrum arises far back on the underside of the head; the tarsi are composed of two nearly equal joints terminating in two claws which have a spine or pad known as a paronychium between them. There are two pairs of wings which are held almost flat or slightly roof-like over the body at rest; the venation is simple. The eggs are small, oval, and attached to the plants by a short or long pedicel. The surface is smooth or sculptured and the color varies from yellow to black. They are normally attached to the undersides of the tender leaves and may be arranged in circles or distributed over the entire surfaces. They are so small as to be scarcely seen without the aid of a lens, and are often covered with the whitish wax from the bodies of the females. The newly hatched young are motile, but lose the legs and antennæ with the first molt. The intermediate forms are soft, oval, flat, and much resemble the soft, unarmored scales. The bodies vary greatly in color and are naked or covered with fine or thick, white, waxy plates or cottony material. There is also often present a fringe of conspicuous, white wax plates or obscure transparent wax filaments. The most characteristic thing, however, is the anal vasiform orifice which is of great importance in classification. The last stage or pupa case is usually more elevated, somewhat segmented, and often discloses the

[1] *Ent. News*, 27, 1916, p. 312.

[2] *Rev. Applied Ent. Ser. A*, 6, 1918, p. 113. Review.

[3] A. L. Quaintance, "American *Aleyrodidæ*. *Tech., Ser.* 8, Div. Ent. U. S. Dept. Agr. 1900.

A. L. Quaintance & A. C. Baker, "Classification of the *Aleyrodidæ*." *Tech. Ser.*, 27, 1, 1913, II. 1914, Bu. Ent. U. S. Dept. Agr. "Contrib. to Our Knowledge of White Flies of the Subfamily *Aleyrodinæ*." *Proc. U. S. Nat. Mus.*, 51, No. 2156, 1917, p. 335.

Florence E. Bemis, "Aleyrodids of California." *Proc. U. S. Nat. Mus.*, 27, No. 1362, 1904, p. 471.

D. D. Penny, "Cat. California *Aleyrodidæ*. *P. C. Jour. Ent. and Zoöl.*, 14, 1922, p. 21.

W. E. Britton, "*Aleyrodidæ*. *Hemiptera* of Conn." Bul. 34, *Conn. Geol. & Nat. Hist. Surv.* 1923, p. 335.

A. C. Baker has very kindly looked over the manuscript of this family and has made certain suggestions. He has stated also that some of the present genera and species will show different grouping when the family is further studied.

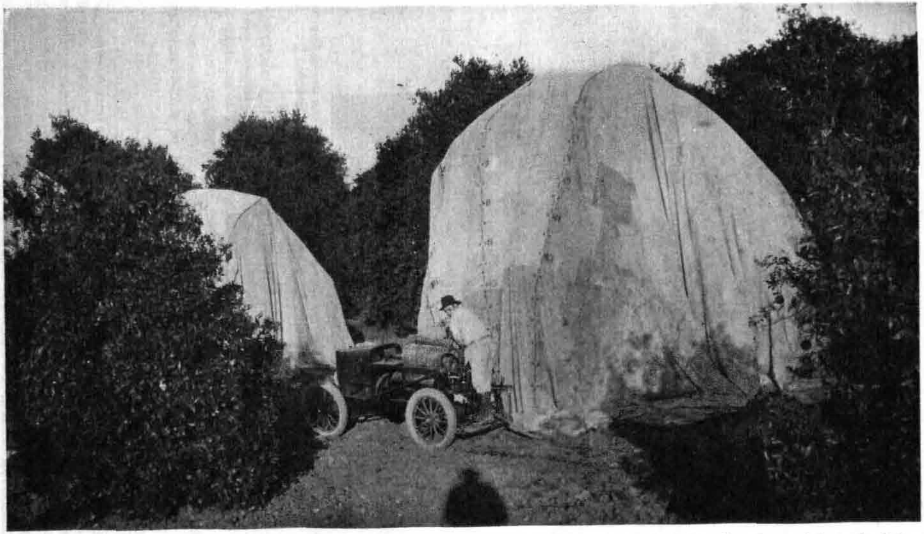

FIG. 209.—The autofumer operating in an orange orchard. In this machine the liquid HCN is first heated by the exhaust of the engine before being conducted under the fumigating tent. (Photo furnished by the California Cyanide Company.)

developing parts of the imago. The adults emerge from this case through a T-shaped slit on the dorsum. There are from two to many overlapping broods a year and the winter is passed in the immature stages.

White flies have much the same feeding habits as other homopterous insects and the young produce quantities of honeydew which is the chief concern to the horticulturist. Few of the species are serious pests, while the great majority are confined to native plants.

The natural enemies are largely parasitic *Hymenoptera* which are exceedingly effective at times.

Artificial control is the same as for plant lice and the scale insects, consisting of sprays and cyanide fumigation.

Three subfamilies are recognized by Quaintance and Baker of which only the *Aleyrodinæ* is represented in our fauna.

When originally described practically all species were in the single genus *Aleyrodes* but many have since been placed in new genera.

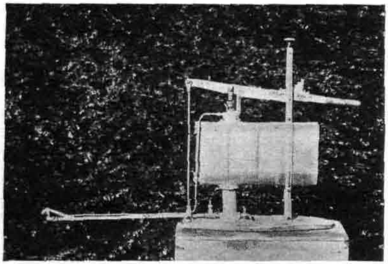

FIG. 210.—A hand atomizer used in spraying the liquid HCN under the fumigating tents directly by hand and without heat. (Photo furnished by H. J. Quayle.)

The citrus white fly, *Dialeurodes citri* (Riley and Howard) (*Aleyrodes*)[1] (Fig. 211), is the most important economic species, being a serious pest of citrus trees in many parts of the world. The adults are 2 mm. long, pale yellow with immaculate white powdered wings. The eggs are pale yellow to greenish and are attached to the apical tender leaves in immense numbers. The immature forms are thin, flat, oval, and so semi-transparent as to be discerned with difficulty on the undersides of the leaves. They vary from 2 to 4 mm. in length. The most important host is citrus but the following are also food plants: allamanda, banana shrub, Boston ivy, cape jasmine, laurel cherry, crape myrtle, coffee, English ivy, *Ficus macrophylla*, green ash, jasmine, lilac, myrtle, mock olive, pear, privet, osage orange, Portugal cherry, pomegranate, prickly ash, smilax, Tree of Heaven, trumpet vine, umbrella tree, water oak, persimmon, and devilwood. This insect

[1] A. W. Morrill and E. A. Back, Bul. 92, Bu. Ent. U. S. Dept. Agr. 1911, p. 11.
E. O. Essig, *Inj. and Ben. Ins. Calif.*, 2d ed. 1915, p. 194.
A. L. Quaintance & A. C. Baker, *Jour. Agr. Research*, 6, 1916, p. 469. *Proc. U. S. Nat. Mus.*, 51, 1917, p. 408.

is primarily a tropical and subtropical species known in China, India, Japan, and in the Southern States and California in North America. In California it is limited to the cities of Marysville, Yuba City, and Sacramento, all of which are quarantined to prevent spread to the citrus orchards of the State. It was first discovered at Marysville in 1907 and later in

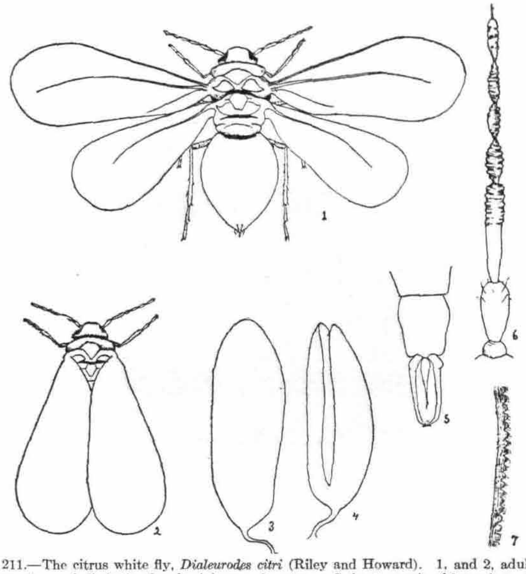

FIG. 211.—The citrus white fly, *Dialeurodes citri* (Riley and Howard). 1, and 2, adults; 3, egg; 4, egg shell; 5, tip of male abdomen; 6, antenna; 7, front margin of fore wing. (After Woodworth.)

Oroville and an attempt was made to eradicate it completely, which was successful in Oroville only. It is controlled by fumigation and spraying as recommended for scale insects on citrus trees.

The crown white fly, *Aleuroplatus coronatus* (Quaintance) (*Aleyrodes coronata* Quaint.) (Fig. 212), is pale yellow in the adult form, 1.1 mm. long, with pure white wings. The pupa case is oval, 1 mm. long, dark, entirely covered with white, waxy plates on the dorsum and surrounded by a broad, sloping rim of gelatinous material. It occurs in great numbers on live, valley, and tan oaks, Christmas berry, manzanita, chestnut, and wild coffee berry throughout California.

The gelatinous white fly, *Aleuroplatus gelatinosus* (Cockerell) (*Aleyrodes*), has a dark brown to black, oval pupal case 1 mm. long, and rests on a thick, gelatinous, transparent or brownish material. The adults have yellow bodies and immaculate wings. The

eggs are yellow, somewhat curved, and have a short pedicel. It is common on the interior live oak and on coffee berry in the western Sierra foothills of California, and occurs on Arizona oak in Arizona.

Kellogg's white fly, *Pealius kelloggi* (Bemis) (*Aleyrodes*) (Fig. 213), is one of the most conspicuous species. The pupa case is elliptical, 1.30 mm. long, pale yellow, without a lateral fringe, but resting upon a ventral fringe of dense, white wax rods and covered dorsally with a series of broad, white, wax ribbons arranged in a beautiful flower-like pattern. It is often present in great numbers on the leaves of the Catalina cherry wherever it occurs naturally or as an ornamental in California.

FIG. 212.—Nymphs of the crown white fly, *Aleuroplatus coronatus* (Quaint.), on underside of leaf of coast live oak.

Maskell's white fly, *Pealius maskelli* (Bemis) (*Aleyrodes*), has the pupa case elliptical, flat, 0.9 mm. long, and pale yellow, without wax fringe or covering. The adults are yellow with immaculate wings. It occurs on tan oak in the central coast counties of California.

The barberry white fly, *Bemisia berbericola* (Cockerell) (*Aleyrodes*), has a colorless, oval pupa case 0.75 mm. long without covering or fringe. The adults are yellow with pure white wings. This species occurs on a barberry in New Mexico.

The inconspicuous white fly, *Bemisia inconspicua* (Quaintance) (*Aleyrodes, Aleuroplatus berbericolus* Q. & B.), has the pupa case oval, 1.16 x 0.80 mm., pale or dark yellow with dorsal pores and markings and only a narrow ventral fringe beneath. The males are 1.11 mm. long and dusky brown. This fly is often associated with other species on California laurel or pepperwood, Christmas berry, clematis, coffee berry, big leaf maple, manzanita, coast live oak, tan oak, and redberry in California. It ranges north into British Columbia and infests Oregon grape, and is also reported from Florida.

The columbine white fly, *Aleyrodes aureocincta* Cockerell, has the adult male 1 mm. long, black with dull ochreous markings and a yellow spot on the dorsum in front of the base of the wings which are white with a dusky spot near the end of each. The pupa is 1 mm. long, oval, black with a wide white or yellow marginal area, and without wax covering or fringe. It occurs on the leaves of columbine in New Mexico.

The azalea white fly, *Aleyrodes azaleæ* Baker and Moles, has the pupa case broadly elliptical, 0.84 mm. long, pale yellow to orange and without waxy secretion and fringe. The adults are pale yellow with immaculate wings. This species occurs on azaleas imported from Japan and Europe and has been taken in California and other States.

The elm white fly, *Aleyrodes essigi* Penny, has an elliptical pale yellow pupa case nearly 1 mm. long without dorsal secretion, but with a narrow marginal fringe. The adults are pale yellow with immaculate wings. The species was taken by the writer in great numbers on elm at the Mission San José, California. It may be an introduced species.

The pruinose white fly, *Aleyrodes pruinosa* Bemis (*A. pruinosus* Bemis) (Fig. 214), gets its name from the frosty covering which nearly hides the oval, yellowish or dark brown, rugose pupa case which is nearly 1.5 mm. long, and convex with a medio-dorsal keel. The small yellow eggs are attached by a short pedicel and are often arranged in circles which are marked by conspicuous white, powdery rings. The adults are 1.8 mm. long, yellow with brown markings and with two dusky spots on each of the fore

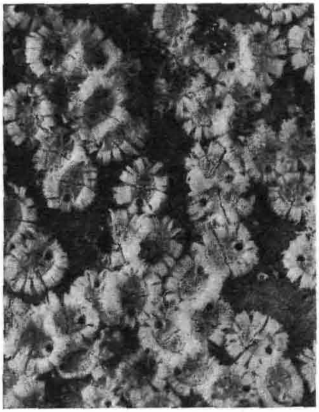

FIG. 213.—Nymphs of Kellogg's white fly, *Pealius kelloggi* (Bemis), on underside of leaf of Catalina cherry.

wings. This species is often abundant in incredible numbers on the undersides of the leaves of the Christmas berry and is responsible for severe smutting of the entire tree over large areas of the coastal regions of Central and Southern California. The variety *euphorbiara* Cockerell has the pupa brownish to black and occurs on Euphorbia in Colorado.

The iris white fly, *Aleyrodes spiræoides* Quaintance, has an oval, pale yellow pupa case 1.20 mm. long, devoid of waxy secretion and fringe. The eggs are pale yellow, oval, 0.30 mm. long, attached by a very short pedicel. The surface is sculptured into polygonal figures. The adults are pale yellowish and have two dusky spots on each of the fore wings and a single one on each of the hind wings. The species is often very abundant and quite destructive to iris, but also feeds on buckeye, fuchsia, wild lettuce, malva, morning glory, wild and cultivated honeysuckle, nightshade, ninebark, plantain, sow thistle, and wild and cultivated tobacco. It occurs throughout the San Francisco Bay region of California.

The fern white fly, *Aleurotulus nephrolepidis* (Quaintance) (*Aleyrodes, A. extraniens* Bemis), has an elliptical, bright yellow pupa case, 1 mm. long, totally devoid of covering and fringe. The adults have immaculate wings. This fly occurs on various kinds of ferns in homes and greenhouses of California.

The deer brush white fly, *Aleurothrixus interrogationis* (Bemis) (*Aleyrodes*), has an elliptical pale yellow to brownish immature stage, 0.70 mm. long, without covering or fringe, but resting on a transparent gelatinous ring. The yellow eggs are attached by a pedicel at one side of the base. The adults are 1 mm. long, dusky white, with immaculate wings. The species occurs on deer brush in the Santa Cruz Mountains, California.

The iridescent white fly, *Aleuroparadoxus iridescens* (Bemis) (*Aleyrodes*), is a common California species. The immature stages are elliptical, dark iridescent with starlike whorls on the surface and a fringe of white filaments one-half as long as the width of the body. The pupa case attains a length of 1.2 mm. The adults are pale yellow with immaculate wings. The fly occurs on California laurel, Christmas berry, coffee berry, manzanita, madrona, redberry, and white sage.

FIG. 214.—Nymphs of the pruinose white fly, *Aleyrodes pruinosa* Bemis, on underside of leaf of the California Christmas berry.

The ambrosia white fly, *Trialeurodes*[1] *ambrosiæ* (Cockerell) (*Aleyrodes*), has a white pupa case and pale yellow adults with six gray spots on each front wing arranged in two transverse rows. It infests Roman wormwood or bitter weed in Colorado.

The corolla white fly, *Trialeurodes corollis* (Penny) (*Asterochiton*), has an elliptical, brown pupa case entirely hidden by broad, white, waxy plates curling over the dorsum to form a crown. It occurs on manzanita in Southern California.

The snowberry white fly, *Trialeurodes diasemus* (Bemis) (*Aleyrodes*), has a yellow pupa case 1.5 mm. long, naked or with both dorsal and lateral secretion. It occurs on wild flowering currant and snowberry in the central coastal area of California.

The small white fly, *Trialeurodes diminutis* (Penny) (*Asterochiton*), has a very small, smoky white pupa case with a few wax rods on the dorsum and a white wax fringe. It infests a low, odorous tarweed known as mountain misery in the western Sierra foothills.

[1] Quaintance and Baker, "Corrigenda, contents and index, Class. of *Aleyrodidæ*." *Tech. Ser.*, 27, Bul. Ent. U. S. Dept. Agr. 1915, p. xi.

The glacial white fly, *Trialeurodes glacialis* (Bemis) (*Aleyrodes*), has a yellow or blackish pupa case nearly 1 mm. long, semi-transparent dorsal rods, and a crystalline submarginal fringe. It is common on wild blackberry, wild clematis, coffee berry, deer brush, ninebark, sage, snowberry, and tan oak, throughout Central California.

Hutchings' white fly, *Trialeurodes hutchingsi* (Bemis) (*Aleyrodes*), has a brownish or black pupal case 1.30 mm. long with a conspicuous long, white submarginal fringe and a lateral crystalline fringe. It occurs on manzanita in the Sierra Nevada Mountains of California.

The madrona white fly, *Trialeurodes madroni* (Bemis) (*Aleyrodes*), has a shining black pupal case 1 mm. long, with a lateral white fringe of thread-like filaments nearly as wide as the case, arranged evenly or separated in groups of plate-like masses, and the dorsum covered with fine, white wax. It occurs on madrona in the coastal region of Central California.

The cottony manzanita white fly, *Trialeurodes merlini* (Bemis) (*Aleyrodes*), has a pale or dark brown pupa case 1 mm. long, entirely covered with a large mass of white, cottony wax. The species often occurs in immense numbers on manzanita bushes

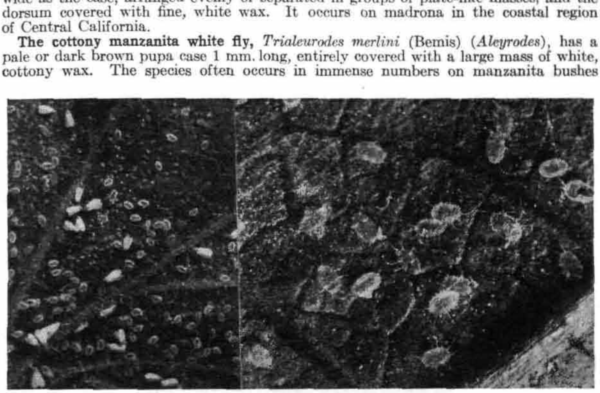

FIG. 215.—The greenhouse white fly, *Trialeurodes vaporariorum* (Westw.). Adults, eggs and nymphs on underside of a geranium leaf.

and gives them the appearance of being covered with snow or cotton, or from a distance, of being whitewashed. It also occurs on madrona and is common throughout the Sierra Nevada Mountains of California.

The tentacular white fly, *Trialeurodes tentaculatus* (Bemis) (*Aleyrodes*), has a yellow, or brown pupa case nearly 1 mm. long, which rests upon a high, ventral fringe of white wax. The dorsum is covered by separate short, tapering, glossy, white wax rods, some of which are much longer than the rest. The adults are yellow with a large, dusky spot on each of the front wings. The species is common on wild clematis, wild honeysuckle, ninebark, live oak, tan oak, and poison oak, in the San Francisco Bay region, California.

The greenhouse white fly, *Trialeurodes vaporariorum* (Westwood) (*Aleyrodes*) [1] (Fig. 215), is one of the most common and troublesome species in greenhouses and gardens. The eggs are elongated, pale yellowish-green, smooth, 0.20 to 0.50 mm. long, and attached by a short, slender pedicel. The young are oval, thin, flat, and semitransparent, pale green in color. The pupa case is slightly convex and 0.75 mm. long. The surface is beset with short and long transparent wax rods or filaments which serve to

[1] H. H. Jewett, *Research Bul.*, 241, Ky. Agr. Exp. Sta. 1922, p. 82.

readily distinguish the species. The adults are 1.50 mm. long, with pale yellow bodies and immaculate wings. The species favors warm, moist conditions and is often abundant and troublesome in greenhouses and lath-houses although it is also common and destructive to many garden plants in California. Among the many hosts are ageratum, alfalfa, aster, avocado, barberry, bean, begonia, bignonia, blackberry, chrysanthemum, clover, coffee berry, coleus, cowpea, cucumber, eggplant, fuchsia, geranium, grape, hibiscus, honey locust, black locust, Jerusalem cherry, lantana, lettuce, loganberry, lupine, Indian mallow, malva, morning glory, muskmelon, nightshade, oxalis, pea, pepper, poison oak, potato, primrose, red bud, rose, sage, soybean, strawberry, tobacco, tomato, vetch, watermelon and wormwood. Cyanide fumigation and spraying with soap afford control.

The grape white fly, *Trialeurodes vittatus* (Quaintance) (*Aleyrodes vittata* Q.), has a naked, dark brown pupa case nearly 1 mm. long, with a narrow,

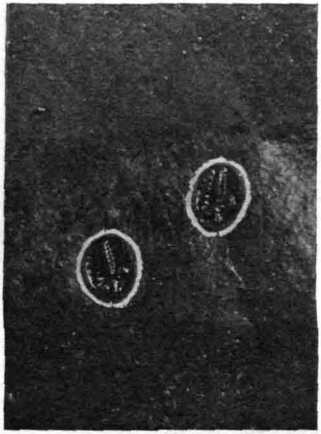

FIG. 216.—Nymphs of the Stanford white fly, *Tetraleurodes stanfordi* (Bemis), on leaf of the coast live oak.

white marginal fringe. The adults have immaculate, white wings. The immature forms of this species often appear in great numbers on the undersides of the leaves of the European grape and cause serious smutting of the fruit and foliage. It has been taken by the writer in the coastal and interior valley regions of California. It normally occurs on chapparal. The use of a soap spray composed of seven pounds of hard fish oil soap to 100 gallons of water proves effective against this fly if applied to the undersides of the leaves.

Wellman's white fly, *Trialeurodes wellmanæ* (Bemis) (*Aleyrodes*), has a naked, dark brown pupal case 0.93 mm. long, without a fringe. It occurs on the leaves of coffee berry in the central coastal region of California.

The acacia white fly, *Tetraleurodes acaciæ* (Quaintance) (*Aleyrodes*), has a shining black pupa case with a short marginal fringe. The dorsum is corrugated and often has three longitudinal rows of powdery secretion. It occurs on acacia in Southern and Lower California and Mexico, and on coffee berry in the central part of California.

Dorsey's white fly, *Tetraleurodes dorseyi* (Kirkaldy) (*Aleyrodes, A. quaintancei* Bemis), has a small, naked, shining black pupa case 0.83 mm. long, with a small inconspicuous white fringe. It occurs on redberry in the central coast region of California.

The laurel white fly, *Tetraleurodes errans* (Bemis) (*Aleyrodes*), has a shining black pupa case with a conspicuous, wide, dense fringe of fine, wax rods, the length of which equals nearly half the width of the case. The adults are yellow with pure white wings. This fly occurs on buckeye, California laurel, and manzanita in the central coast region of California.

Herbert's white fly, *Tetraleurodes herberti* Penny, has a shining black pupa case nearly 1 mm. long with but few inconspicuous dorsal wax rods. It occurs on honey locust in Alameda County, California.

The black aleyrodid, *Tetraleurodes nigrans* (Bemis) (*Aleyrodes*), has a dull black pupa case nearly 1 mm. long without a conspicuous white fringe. The eggs are dark yellow or brown with a very short pedicel. It is a common species throughout California occurring on Catalina cherry, Christmas berry, wild clematis, coffee berry, deer brush, wild honeysuckle, California laurel, madrona, manzanita, snowberry, white sage, and yerba santa.

The splendid white fly, *Tetraleurodes splendens* (Bemis) (*Aleyrodes*), has a shining black or dark brown pupa case nearly 1 mm. long, with a narrow, submarginal yellow stripe and two wedge-shaped, transparent spots on the cephalic region. The marginal fringe is composed of densely laid, long, white wax rods longer than the width of the case. The eggs are dark yellow with a long pedicel at one side of the base. The species occurs on coffee berry and manzanita throughout California.

The Stanford white fly, *Tetraleurodes standfori* (Bemis) (*Aleyrodes*) (Fig. 216), has a shining black pupa case 0.85 mm. long, with a conspicuous white fringe, slightly less than half the width of the case. The eggs are yellow and attached by a short pedicel at one side of the base. The fly is common and abundant throughout California on the coast live oak, and less common on tan oak and coffee berry.

The bear berry white fly, *Tetraleurodes usorum* (Cockerell) (*Aleyrodes*), has a black, naked pupa case with a small amount of white wax at the base, but is devoid of a distinct fringe. The adults are dark with white wings, each fore wing bearing a dusky spot and cloudy area. This species occurs on bear berry in Colorado.

CHAPTER XXII

HEMIPTERA (Order) [1]

(*Hemi*, half; *pteron*, wing)

Bugs

The true bugs are mostly large, easily distinguished insects although a few are exceedingly small and easily overlooked. They comprise a large order characterized by the dissimilar wings, the front pair being composed of a thick, coriaceous base and the tips membranous, and are called hemelytra. The hind wings are membranous (Fig. 217). When the wings are folded the membranous tips of the front wings overlap so as to form a more or less distinct "X" on the back. The young and the adults of many species are wingless. Ocelli are usually present but are absent in many. The antennæ are short, particularly in the aquatic forms and concealed under the head, whilst in the land forms they are usually long and well developed. The rostrum is short or very long, arises from the front of the head, and is held close to the sternum when not in use. A large number of bugs are aquatic, living at the bottom or on the surface. A few are semi-aquatic, inhabiting the wet margins of streams and pools, while the great majority are terrestrial living on plants. The aquatic and semi-aquatic forms are practically all predaceous on small animals, chiefly insects, and while the terrestrial forms are mostly herbivorous, a few are also important predators on other insects. As among the *Homoptera*, feeding consists in puncturing and extracting the juices from plants and animals. Many bugs emit a powerful, offensive odor as a means for protection and are known as stink bugs. There is usually but a single brood annually, but there may be two or more. The winter is passed in the adult stage. The eggs are most interesting and of most curious forms, often beautifully ornamented.

The young are much like the adults in general appearance and are wingless until nearly mature when the wing pads begin to develop. They are commonly called nymphs.

The natural enemies consist largely of hymenopterous egg parasites,

[1] The members of this order were formerly grouped in a suborder *Heteroptera*.
The author is indebted to E. P. Van Duzee for reading the manuscript of this order.
Otto Heidemann, "Eggs of *Hemiptera-Heteroptera*." *Proc. Ent. Soc. Wash.*, 13, 1911, p. 128.
F. Muir & J. C. Kershaw, "Mouth-parts of *Hemiptera*." *Psyche*, 18, 1911, p. 1.
E. P. Van Duzee, "Cat. *Hemiptera* of Am. North of Mexico." *Univ. Cal. Pub. Tech. Bul. Ent.* 2, 1917. Complete Bibliography.
H. M. Parshley, "*Hemiptera* of British Columbia." *Proc. B. C. Ent. Soc.*, 1921, p. 13. "*Hemiptera* of Conn." *Conn. Geol. and Nat. Hist. Surv.*, Bul. 34, pp. 383–783, 1923. "Biblio. N. A. *Hemiptera-Heteroptera*." *Anniv. Ser. Smith College*, vol. 4, pp. 1–252, 1925. (Complete Bibliography.)

which are often exceedingly effective, and of insect predators which consume great numbers of the young.

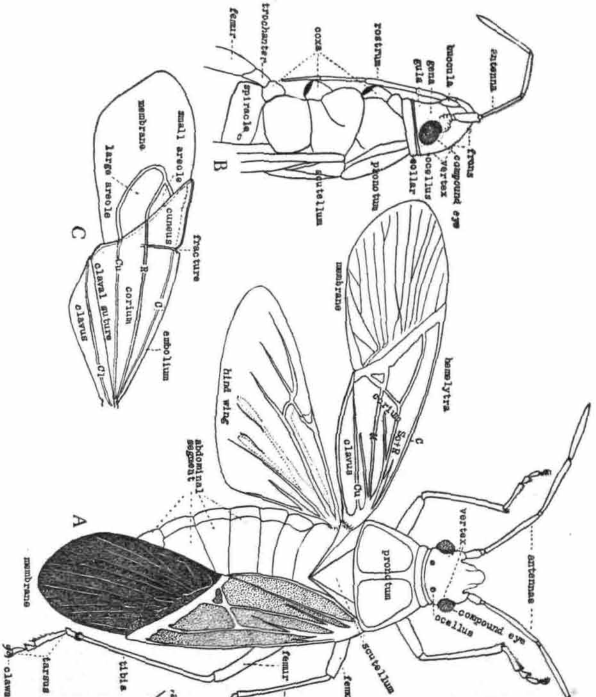

FIG. 217.—External anatomy of *Hemiptera*. A, the box-elder plant bug, *Leptocoris trivittatus* (Say), with the hemelytron and wing spread; B, same, side view of head and thorax; C, hemelytron of the tarnished plant bug, *Lygus pratensis* (Linn.).

Control measures are rather difficult and often very unsatisfactory. The soap and nicotine sprays and dusts recommended for the plant lice are often very effective for destroying the young bugs. Thorough cleaning out of dead host plants and rubbish in the fall, and clean culture throughout

the year are important considerations. Cyanide dust has proven to be a very effective insecticide in controlling these insects.

The order *Hemiptera* is too large to admit of a thorough discussion. Only the more important families and species are included.

KEY TO FAMILIES

(Fig. 217).

(After H. M. Parshley, Bul. 34 Conn. Geol. and Nat. Hist. Survey, 1922, p. 383).

1. Antennæ shorter than the head, generally concealed in cavities between head and thorax; metasternal orifices absent.................................. 2
   Antennæ as long as or longer than the head, exposed........................ 8

2. Ocelli present; littoral species; not over 10 mm. in length.................... 3
   Ocelli absent; aquatic species.. 4

3. Antennæ exposed; front legs similar to intermediate............ **Ochteridæ**
   Antennæ concealed; front legs raptorial (Toad Bugs) **Nerthridæ** or **Gelastocoridæ** p. 368

4. Hind tarsi without two distinct claws (except *Plea* which is less than 3 mm. in length); front legs not raptorial in structure; moderate or small in size.... 5
   Hind tarsi with claws; front legs raptorial.................................... 6

5. Head overlapping thorax dorsally; body flattened above (Water Boatmen) **Corixidæ** p. 368
   Head inserted in thorax; body convex above (Back Swimmers). **Notonectidæ** p. 365

6. Membrane reticulately veined; large in size.................................. 7
   Membrane without veins; moderate in size (Water Creepers) .. **Naucoridæ** p. 366

7. Apical appendages of abdomen long and slender, not retractile; hind legs not flattened (Water Scorpions)................................ **Nepidæ** p. 366
   Apical appendages of abdomen short and flat, retractile; hind legs distinctly flattened, natatorial (Giant Water Bugs)................ **Belostomatidæ** p. 366

8. Head shorter than thorax including scutellum.............................. 9
   Head as long as entire thorax, both elongated; body and appendages slender; aquatic, length about 11 mm. (Water Measurers)........... **Hydrometridæ**

9. Claws of at least the front tarsi distinctly anteapical with terminal tarsal segment more or less cleft; aquatic, living on the surface...................... 10
   Claws all apical, last tarsal segment entire; aquatic and terrestrial forms........ 11

10. Hind femora extending much beyond apex of abdomen; intermediate and hind pairs of legs approximated, very distant from front pair; ocelli present, but sometimes very obscure; moderate in size (Water Striders)....... **Gerridæ** p. 364
    Hind femora not extending much beyond apex of abdomen; intermediate pair of legs about equidistant from front and hind pairs (except in *Rhagovelia*); ocelli obsolete or absent; moderate to minute in size (Veliids)..... **Veliidæ** p. 364

11. Antennæ five-segmented.. 12
    Antennæ four-segmented, disregarding minute ring segments; (antenniferous tubercles of head should not be mistaken for segments).................... 13

12. First and second segments of antennæ thicker than the others; minute in size (Hebrids).................................... **Næogeidæ** or **Hebridæ**
    First segment of the antennæ thickened, second slender; margin of head carinate above insertion of antennæ; moderate in size, rarely minute................ 32

13. Prosternum with a median longitudinal transversely striated or granulated stridulatory groove visible anterior to front coxæ, receiving the tip of the rostrum; rostrum three-segmented, short and strong; length not less than 5 mm.. 14
Prosternum without a stridulatory groove; size large or small............... 15

14. Terminal segment of antennæ thickened; front legs highly modified, stout, raptorial; moderate in size (Ambush Bugs).................. **Phymatidæ** p. 354
Terminal segment of antennæ filiform (sometimes faintly divided into numerous small parts); front legs usually much like the others, though raptorial in function, sometimes somewhat thickened and spinous; large or small in size (Assassin Bugs, Kissing Bugs, etc.)............................ **Reduviidæ** p. 355

15. Hemelytra closely reticulate in relief, membranous between the reticulations, more or less lace-like in appearance, size small............................ 16
Hemelytra not so reticulate, or absent; size large or small..................... 17

16. Juga free, produced before apex of head, longer than tylus; hemelytra with a non-reticulate membrane, the rest reticulately punctate; one small species **Piesmidæ**
Juga not prominent, not longer than the tylus; head sometimes with dorsal anteriorly projecting spines; hemelytra of similar texture throughout, densely reticulate; numerous small species (Lacebugs)................. **Tingidæ** p. 351

17. Pronotum divided into three lobes; head contracted behind the eyes; hemelytra wholly membranous, with a few distinct longitudinal and cross veins; very minute and delicate forms.............................. **Enicocephalidæ**
Pronotum, head, and hemelytra otherwise constructed...................... 18

18. Rostrum really or apparently three-segmented............................ 19
Rostrum four-segmented, first segment sometimes short..................... 23

19. Body convex below, flat or slightly concave above; greenish in color; clavus membranous, similar in texture to the membrane, the latter without veins, corium somewhat thickened; small aquatic predatory species living generally on floating vegetation (Mesoveliids)......................... **Mesoveliidæ**
Body usually very thin, flat above and below; when not distinctly flattened hemelytra are not constructed as above; color not greenish; terrestrial or riparian.. 20

20. Tarsi two-segmented; flattened species of moderate size living under dead bark (Flat Bugs)... **Aradidæ** p. 346
Tarsi three-segmented.. 21

21. Ocelli present.. 22
Ocelli absent; hemelytra always much reduced, without membrane; rather small parasitic species (Bedbugs).......................... **Cimicidæ** p. 359

22. Hemelytra provided with a cuneus, membrane without long closed cells, sometimes without veins; sometimes brachypterous; small in size (Minute Pirate Bugs).. **Anthocoridæ** p. 360
Hemelytra without a cuneus; membrane with four or five long closed cells; moderate or small in size (Shore Bugs)...................... **Saldidæ** p. 365

23. Ocelli absent.. 24
Ocelli present, except in certain *Lygæidæ* which may be distinguished by the venation and ring structure.. 26

24. Membrane with two large cells at base from which extend about eight branching veins; hemelytra without a cuneus; rather large strong forms (Red Bugs, Stainers).. **Pyrrhocoridæ** p. 350

Membrane with one or two small cells at base, very rarely with longitudinal veins; cuneus distinct; rather small delicate forms........................ 25

25. First segment of rostrum longer than broad, extending generally somewhat beyond posterior margin of head; membrane with two small cells at base or rarely one (Leaf Bugs, Plant Bugs)........................... **Miridæ** p. 360
First segment of rostrum little or not longer than broad, extending posteriorly not farther than middle of eyes; membrane with one cell..... **Termatophyiidæ**

26. Hemelytra without a cuneus, not Mirid-like; size large or small................ 27
Hemelytra with a cuneus; small Mirid-like forms................. **Isometopidæ**

27. Front legs not especially modified for grasping, generally much like the others, front femora sometimes thickened and armed with a few teeth; first segment of rostrum generally longer than wide.................................... 28
Front legs raptorial, the tibiæ and usually the femora armed with rows of numerous closely set spines which interlock when the leg is flexed, front femora more or less thickened, the femoral spine sometimes replaced by closely set even setæ; first rostral segment short, moderate in size (Damsel Bugs) **Nabidæ** p. 358

28. Body and appendages not extremely slender, antennæ otherwise constructed... 29
Body and appendages extremely slender, linear; antennæ geniculate, biclavate; eyes distant from base of head; moderate in size (Stilt Bugs).... **Neididæ** p. 346

29. Membrane with numerous more or less anastomosing veins; antennæ inserted high, usually above a line drawn from the middle of the eye to the anterior end of the buccula.. 30
Membrane with five usually simple veins; antennæ inserted low on the side of the head, usually below or on such a line; moderate or small in size, sometimes brachypterous (Chinch Bugs)............................... **Lygæidæ** p. 346

30. Metasternal orifices distinct, placed farther outward; colors usually dark; generally over 10 mm. in length.. 31
Metasternal orifices generally obsolete, when present placed between intermediate and hind coxæ near median line, with two diverging furrows running outwards; moderate or small in size (Corizid Bugs) .... **Corizidæ** p. 344

31. Head much narrower and shorter than the pronotum; bucculæ extending posterior to insertion of antennæ; moderate or large in size (Squash Bugs) **Coreidæ** p. 342
Head much larger proportionally, the part between the eyes wider than the scutellum; bucculæ anterior to insertion of antennæ; moderate in size **Alydidæ**

32. Scutellum generally large, covering almost the whole of abdomen, usually very convex; when scutellum is reduced in size and flattened, tibiæ are strongly spinose.. 33
Scutellum generally moderate in size, more or less narrowed apically; scutellum rarely covering most of the abdomen, in which case, in our species, colors are bright and contrasting, or there is a prominent tooth just anterior to lateral angles of pronotum; tibiæ not strongly spinose but sometimes bear very small spines or a more or less hair-like vestiture which may have a spinose appearance; moderate in size (Stink Bugs)..................... **Pentatomidæ** p. 337

33. Tibiæ thickly set with long strong dark colored spines; corium narrow, acute or rounded apically; moderate in size (Negro Bugs)........... **Cydnidæ** p. 337
Tibiæ not strongly spinose; corium broad, obtuse at apex; moderate in size (Shield Bugs).. **Scutelleridæ**

SCUTELLERIDÆ. Shield Bugs.

The black-faced shield bug, *Homœmus æneifrons* (Say), is a small, pale or dark brown species, 8 mm. long, with a dark face and indefinite or obsolete

darker markings on the dorsum. It commonly occurs in dry grasses and is reported in British Columbia, California, Nevada, New Mexico, and Colorado. It occurs throughout the United States.

The bijugate shield bug, *Homœmus bijugis* Uhler, varies from 8 to 9 mm. in length and is pale brown strongly marked with dark, oblique lines on the dorsum, and often has a dark face and a prominent white, posterior median dorsal streak. It occurs on grasses, wheat, oats, timothy, alfalfa, and weeds, in the States west of the Mississippi River, and is recorded in the west in California, Nevada, Arizona, Utah, Colorado, and New Mexico.

The alternate shield bug, *Eurygaster alternatus* (Say), is a pale or dark brown species 9 mm. long, with indefinite or distinct oblique or zigzag darker markings on the dorsum and a regular row of dark marginal spots. It is common in alfalfa, grasses, and weeds throughout North America, and is known in the west in British Columbia, Oregon, California, Nevada, Utah, Montana, Colorado, and New Mexico.

CYDNIDÆ. Negro Bugs, Burrower Bugs.

The common negro bug, *Thyreocoris extensus* (Uhler) (*Corimelæna*) (Fig. 218), is a *very small, shining black bug 3 to 4 mm. long slightly elongated, convex with cream* or orange line on the sides of the elytra. The eggs are pink or orange, elongate, *rounded on the top, and slightly smaller at* the base. They are laid single on the leaves. This bug occurs on wild tobacco and weeds *in* Oregon, California, Arizona, Utah, Colorado, New Mexico and attacks tomato in California. There are a number of species *of negro bugs similar to the above* which must not be confused with it.

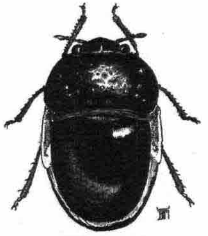

FIG. 218.—The common negro bug, *Thyreocoris extensus* (Uhler).

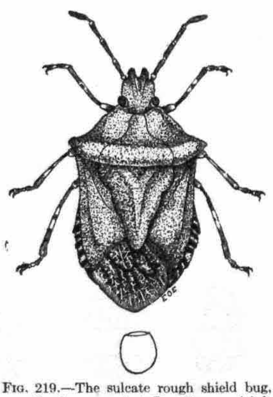

FIG. 219.—The sulcate rough shield bug, *Brochymena sulcata* Van Duzee. Adult female and egg.

PENTATOMIDÆ. Stink Bugs.

The rough plant bugs belonging to the genus *Brochymena* are large, rough brown and gray bugs from 12 to 15 mm. long, most often found on shrubs and trees, and also occurring on fruit trees. The eggs are pearly white, elongate oval, 1 mm. long, and laid on twigs or leaves in small groups. The nymphs and adults are beneficial, being predaceous on caterpillars, beetles, and other insects. *B. affinis* Van Duzee occurs on pine and other forest trees in Northern California, Washington, and Idaho. *B. arborea*

(Say) is a common eastern species ranging into New Mexico, Arizona, and Mexico. *B. 4-pustulata* (Fabr.) (*B. annulata* Uhler) occurs throughout North America and is known in California, Nevada, Utah, Colorado, Arizona, and New Mexico. *B. sulcata* Van Duzee (Fig. 219) is the common species found in the deciduous fruit orchards of Central and Southern California and has often been confused with *B. 4-pustulata* (Fabr.). The adults hibernate on the trees and may be taken throughout the year. *B. tenebrosa* Walker (*B. obscura* H. S.) is common on fruit trees in New Mexico and also occurs in Texas, Arizona, Colorado, Utah, Nevada, Oregon, and California. The egg parasite, *Trissolcus euschisti* Ashm., has been reared from the eggs in New Mexico.[1]

The conchuela, *Chlorochroa ligata* (Say)[2] (*Pentatoma*), is a large, dark olive green bug 15 mm. long, with the tip of the scutellum and a narrow marginal border orange or reddish. The eggs are first pale green, turning gray or brown as the embryo develops. They are somewhat cylindrical in shape, 0.95 x 1.22 mm. in dimensions, and are laid in compact groups on the leaves. The nymphs are variable in color from gray to olive brown with orange or reddish markings. They are gregarious in habit, living in compact colonies. This species is often a serious pest to cotton bolls in Texas, but is not known to attack cultivated cotton in either Arizona or California, although it is often found on wild cotton in Arizona. Besides the wild cotton it also attacks alfalfa, asparagus, and wild mustard in Arizona and California, and hemlock and grape elsewhere. The distribution includes Mexico, Texas, New Mexico, Arizona, Colorado, Utah, California, British Columbia, and probably intervening States.

Say's plant bug, *Chlorochroa sayi* Stål (Fig. 220), is much like the preceding in size and shape and differs in color by being bright green with minute white specks and three small, pale or orange spots at the base of the scutellum, the tip of which is more often whitish than orange, and with a narrow yellow or orange margin. It is often injurious to the heads of wheat by destroying the developing kernels, and also feeds on alfalfa, asparagus, beans, cotton, oats, peas, sage, sunflower, grasses, and weeds. It is a western bug occurring in Kansas, Montana, Idaho, Utah, Colorado, Nevada, Arizona, and California.

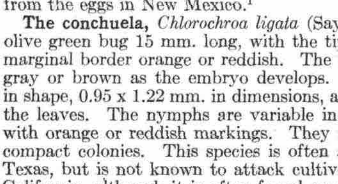
Fig. 220.—Say's plant bug, *Chlorochroa sayi* Stål.

The green plant bug, *Chlorochroa uhleri* Stål, is a bright green species 14 mm. long, with dusky scutellum having two small, pale basal spots, and with the basal margins of the front wings yellow. Its habits are much like the preceding species and it often

[1] T. D. A. Cockerell, *Can. Ent.*, 29, 1897, p. 26.
[2] A. W. Morrill, Bul. 86, Bur. Ent. U. S. Dept. Agr. 1910, p. 23. Also *Jour. Econ. Ent.*, 10, 1917, p. 309.

seriously injures the heads of standing wheat in the Western States, where it is known to occur in Alaska, California, Idaho, Montana, Utah, Colorado, and Arizona. The distribution includes much of North America.

The consperse stink bug, *Euschistus conspersus* Uhler (Fig. 221), is small, 12 mm. long, pale brown, covered with small black specks on the dorsum, yellow beneath and with red antennæ. It is a pest to berries, feeding on and destroying the drupelets thereby causing a withering and drying up. It has been taken by the writer on blackberry, loganberry, and raspberry, and often leaves a very disagreeable odor on the fruit. It occurs in British Columbia, Washington, Oregon, and California. *E. euschistoides* (Vollenhoven) (*E. fissilis* Uhler) attacks alfalfa in New Mexico, and has a wide range in North America, being known in British Columbia, Montana, and Colorado. **The brown cotton bug,** *E. impictiventris* Stål, is a small, dark brown species 10 to 12 mm. long which is common on cotton in Arizona.[1] It is also common in Texas, New Mexico, Colorado, Utah, California, Nevada, and British Columbia. *E. servus* (Say) also attacks cotton, as

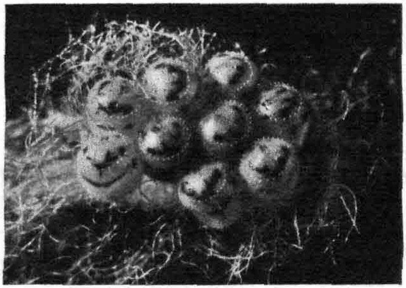

FIG. 221.—Eggs of the consperse stink bug, *Euschistus conspersus* Uhler. (Photo furnished by F. J. Spruÿt.)

well as cabbage, corn, coneflower, peach, and blackberry, and occurs throughout the Eastern United States and in the west in Texas, New Mexico, and Colorado.

The conspicuous stink bug, *Cosmopepla conspicillaris* (Dallas), varies from 6 to 8 mm. in length, is shiny blue-black with a conspicuous but variable orange band across the prothorax which often incorporates a pair of black eye-like spots near the middle. The tip of the scutellum is lined white and there is also a short white line cutting the middle of the orange band. This species is often common on hedge nettle in California. It is also known in British Columbia, Washington, Oregon, Nevada, Montana, Utah, Colorado, and Mexico.

The red-shouldered plant bug, *Thyanta custator* (Fabr.),[2] is a bright green bug 8 to 12 mm. long, usually with a distinct, dark red band across the shoulders, although this band may be entirely absent. It is a very common species on grasses, grains, flowers, weeds, berries, fruit trees, alfalfa, cotton, cowpeas, corn, oats, and sorghum.

[1] A. W. Morrill, *Jour. Econ. Ent.*, 10, 1917, p. 309.

[2] E. O. Essig, *Inj. & Ben. Ins. Calif.*, 2d ed. 1915, p. 199.

The eggs are oval, white, covered with minute bristles and chorial processes around the cap. The bug occurs throughout North America and is known in British Columbia, Washington, Oregon, California, Nevada, Arizona, Utah, Colorado, New Mexico, and Mexico. **The small plant bug,** *T. brevis* Van Duzee, is a pale green species much like the preceding but lacks the red band and is only about half as large. It often occurs in great numbers on atriplex in the San Joaquin Valley, California, and according to H. H. P. Severin, has distinct summer flights from the native breeding grounds. It also inhabits Nevada, Utah, Idaho, Colorado, Arizona, and Texas. *T. perditor* (Fabr.) is bright green, from 6 to 9 mm. long, with sharp-pointed shoulders. It is neotropical, ranging from Mexico into the Southern States and into New Mexico, Arizona, and Southern California.

The harlequin cabbage bug, *Murgantia histrionica* (Hahn) [1] (*M. nigricans* Ckll.) (Figs. 222, 223), is a beautiful black bug with bright red markings on the dorsum. The size varies from 8 to 11 mm. The eggs are cylindrical,

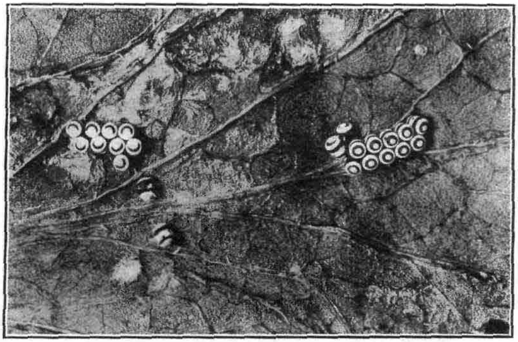

FIG. 222.—Eggs of the harlequin cabbage bug, *Murgantia histrionica* (Hahn), on cabbage leaf.

white, with conspicuous black rings and a single, small, black spot, and are often likened to miniature, white barrels with black hoops. They are arranged in regular or irregular groups almost anywhere on the host plants. The nymphs are polished black with white, yellow, orange, and red markings. The insect is active in our region throughout the year, the winter being passed in the adult stage. During cold weather the adults hide away but appear on warm days. In the Southwestern States feeding appears to continue throughout the winter as well as the summer. In the northern limits there appears to be but a single, uneven, and long-drawn-out brood a year, the eggs being laid chiefly during June and July. There are apparently at least two broods in the warmer sections of New Mexico, Arizona, and Southern California. This insect is a serious garden pest, particularly to such cruciferous plants as brussels sprouts, cabbage, cauliflower, collards,

[1] E. O. Essig, *Inj. & Ben. Ins. Calif.*, 2d ed. 1915, p. 200. Also *P. C. Jour. Ent. and Zoöl.*, 14, 1922, p. 76.
F. H. Chittenden, *Farmers' Bul.* 1061, U. S. Dept. Agr. 1920.

kale, kohl-rabi, horseradish, mustard, radish, rape, streptanthus, and cress, but it also feeds on asparagus, bean, beet, citrus, cherry, chrysanthemum, corn, eggplant, grape, lambsquarters, wild and cultivated lettuce, locust, loquat, okra, pigweed, plum, potato, ragweed, rose, squash, and sunflower. In Southern California the native food plants are wild mustard and wild bladder-pod, while in New Mexico the native host appears to be the Colorado honey plant. The distribution embraces Central America, Mexico, and the United States, but in the west it occurs only in Colorado, New Mexico, Arizona, Nevada, and California, and is rare in the first of these States.

Control measures consist in clean culture, the use of trap crops which are destroyed with the insects after they become infested with the adults in the spring, and hand-picking in the spring to eliminate the egg-laying

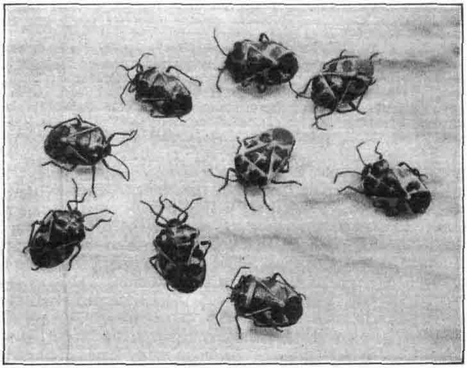

FIG. 223.—The harlequin cabbage bug, *Murgantia histrionica* (Hahn), on cabbage leaf.

females. The use of a soap and nicotine spray as suggested for plant lice is often effective in warding off the attacks.

The green soldier bug, *Acrosternum hilaris* (Say) (*Pentatoma, Nezara*),[1] is large, 14 to 18 mm. long, bright green, with the entire lateral margin lined yellow, orange, or reddish. The three apical, antennal articles are marked with black. This bug is a very general feeder on apple, bean, box elder, cabbage, catalpa, corn, cotton, okra, dogwood, eggplant, elderberry, linden, maple, mesquite, mustard, orange, pea, peach, sand cherry, tomato, and turnip. W. W. Jones reports it as a serious pest to peaches in Utah. The distribution embraces much of North America, Central America, and the northern part of South America. In the west it is known in California, Arizona, Utah, Colorado, and Montana. *A. marginatum* (P. B.) is a neotropical species ranging from South America northward into Texas, New Mexico, Arizona, and California. It punctures and feeds on the pods of the western red bud.

The pine bug, *Dendrocoris pini* Montandon, is pale yellow ochraceous in color and from 5 to 6 mm. long. It feeds on the one-leaf piñon pine in California, and also occurs in Arizona, Utah, Colorado, and Texas.

[1] R. D. Whitemarsh, Bul. 310, Ohio Agr. Exp. Sta. Feb. 1917.

The anchorage bug, *Stiretrus anchorago* (Fabr.), is 8 to 9 mm. long, with large scutellum, and of many variable color patterns from entirely metallic dark blue to greenish black or violet marked with orange or red. The nymphs are wholly black or black with a large red spot on the dorsum. It is a beneficial predaceous bug which lives in bushes and trees, and feeds on caterpillars, larvæ of leaf beetles, including the Colorado potato beetle, and other insects. Four distinct varieties are recognized by Van Duzee. It ranges from Panama to Canada and as far west as New Mexico.

The bioculate predaceous bug, *Perillus bioculatus* (Fabr.), is a small bug 9 mm. long; the typical form is black with numerous reddish markings on the dorsum, while the variety *clanda* (Say), is black or brown with white markings on the dorsum and the elytra white with median black lines. It is predaceous on armyworms or cutworms, other caterpillars, and the larvæ of various beetles, and is particularly effective against the young of the Colorado potato beetle. It has a wide distribution in North America and occurs in practically every State in the west.

The yellow bug, *Apateticus crocatus* (Uhler) (*Podisus*), is a large species 15 mm. long, and varying from saffron yellow to pale brown or fawn and often mottled with dark metallic green.[1] The eggs are cylindrical, 1.07 mm. high, white changing to brownish-black with whitish markings and a white rim band, top and bottom convex, and rim of cap surrounded by incurving spine-like chorial processes which are white tipped black. They are usually laid in double rows on twigs of fruit and other trees. This is a beneficial bug which feeds extensively on various caterpillars such as cankerworms, oak moth, and other smooth caterpillars. It is widely distributed throughout the west, being recorded in British Columbia, Washington, Oregon, California, Utah, Colorado, and Arizona. A closely related species, *A. cynicus* (Say), is brown and lays reddish-brown eggs each of which have a circle of about 20 short, club-shaped chorial processes around the cap. It is generally distributed throughout the United States and Canada, and occurs as far west as Arizona and Colorado. It also feeds chiefly on caterpillars.

The spined predaceous bug, *Podisus maculiventris* (Say) (*P. spinosa* Dallas), is yellowish or pale brownish, the dorsum entirely covered with small black specks, the venter pale with a conspicuous black spot in the anal region, and the wing membranes with a short, black line near the apices which extend beyond the tip of the body. The shoulders are sharply pointed. There is a conspicuous spine on the underside of the middle of the front tibiæ. The length varies from 10 to 12 mm. The eggs are metallic bronzy black, 1.4 mm. long, with about 14 chorial processes around the cap. They are laid in masses of from 8 to 30 or more. This very beneficial predaceous bug has a wide distribution throughout North America and occurs in all of the western area. It feeds on many kinds of harmful insects but chiefly on the smooth caterpillars of butterflies, cankerworms, California oak moth, and cutworms. It does not, however, confine its attacks to injurious insects alone but also devours the larvæ and adults of ladybird beetles, lacewings, and is also cannibalistic.

COREIDÆ. Squash Bugs.

The leaf-footed plant bugs belonging to the genus *Leptoglossus*[2] are usually medium-sized or large bugs, nearly flat on the back, and often with characteristic leaf-like enlargements on the hind tibiæ. They are plant feeders and at times quite destructive. The most destructive species is **the chincha or western leaf-footed plant bug,** *L. zonatus* (Dallas) (*Anisoscelis*). The adults average about 20 mm. in length, and are of a uniform brown with two yellow spots on the prothorax, an irregular narrow band across the middle of the hemelytra and yellow lines on the margins of the abdomen

[1] W. Downes, *Proc. B. C. Ent. Soc.*, 1920, p. 21.
[2] E. H. Gibson, Key to Species. *Psyche*, 24, pp. 69-73, 1917.

and the leaf-like enlargements of the hind tibiæ. The nymphs are bright red and black. This species ranges from Central America through Mexico and Lower California into Arizona and Southern California. In Arizona its favorite food appears to be the fruit of the pomegranate, although it also feeds on and injures the bolls of cotton,[1] the fruit of young green oranges and green and ripe peaches. It is thought to spread the heart rot disease of pomegranates. In Lower California it has been found injurious to cotton, dates, limes, oranges, and watermelons.[2] It has been taken only on cotton in Southern California, but is likely to become of importance in developing fruit sections of the Imperial Valley. *L. phyllopus* (Linn.) is considerably smaller than the preceding, being about 18 mm. long and also more slender. The yellow cross line is more even and narrower. It has been found to feed on the bolls of cotton and on dock, thistles, and yucco in Arizona. It ranges from South America into the Southern and Eastern States as far north as New York, and into Arizona in the west. *L. clypealis* Heidemann is 16 to 20 mm. long, yellowish brown covered with short, golden hairs and distinguished by the head terminating in a stout spine. It is a western species known in Oregon, California, Utah, Colorado, Arizona, and New Mexico, and is abundant in yucca flowers in the spring. *L. occidentalis* Heidemann is 16 to 18 mm. long, reddish-brown, densely pubescent with a yellow zigzag line across the hemelytra much like *L. zonatus* (Dallas). It is also western, occurring in British Columbia, Washington, Oregon, California, Idaho, Nevada, and Colorado.

The bugs belonging to the genus *Narnia* are not greatly different from the leaf-footed bugs. They are often quite destructive to various species of cactus. *N. femorata* Stål, is often abundant on and destructive to the fruits of *Opuntia* and *Cereus* in Texas, Mexico, New Mexico, Arizona, and Southern California. *N. inornata* Distant feeds on the joints of *Opuntia* in Southern California and Mexico. *N. pallidicornis* Stål is often very abundant on *Opuntia* in, Mexico, Texas, Arizona, and California. *N. snowi* Van Duzee occurs on the joints of *Opuntia* in New Mexico and Arizona. *N. wilsoni* Van Duzee is common on melon or nigger-head cactus in Arizona and Southern California.

The cactus joint bug, *Chelinidea tabulata* (Burmeister),[3] is a robust species, flat on the dorsum, varying in color from yellow to reddish brown, dark olive green or nearly black, with parts of the head, prothorax, legs, and wing membranes darker brown or blackish. The length is 12 to 15 mm. The eggs are elliptical, dark brown mottled with whitish exudation, with finely punctured surface, and 1 mm. in length. They are laid in rows of from 12 to 50 on the cactus spines. The nymphs are brownish or dusky with pale green or reddish abdomen. The bugs are nocturnal, often congregating in large numbers on the joints of cactus and causing yellowing, withering, and gradual death of the plants. The species occurs in the arid regions of Texas, New Mexico, Colorado, Arizona, and Southern California. *C. vittiger* Uhler very greatly resembles the former in size, color, and habits. It occurs in various parts of Mexico and the United States, and in the following Western States: New Mexico, Colorado, Utah, Idaho, Arizona, and California. It feeds on cactus, often in company with the former species.

The clematis bug, *Ficana apicalis* (Dallas) (*Gonocerus*), greatly resembles a miniature squash bug, averaging about 13 mm. in length. It inhabits Mexico, Arizona, California, and Colorado, and feeds on wild clematis.

The squash bug, *Anasa tristis* (De Geer) (*Cimex*)[4] (Fig. 224), is a common destructive species throughout Central and North America. The adults

[1] A. W. Morrill, *Jour. Econ. Ent.* 10, 1917, p. 310.
[2] R. H. Forbes, *Ent., News*, 16, 1905, p. 18.
[3] E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 203.
[4] F. H. Chittenden, "The Common Squash Bug." *Circ.* 39, 2d ser. Bur. Ent. U. S. Dept. Agr. 1908.
D. G. Tower, "Mouth Parts of the Squash Bug." *Psyche*, 21, 1914, p. 99.

are pale or dark grayish brown on the dorsum and paler beneath, the protruding margins of the abdomen are orange or alternately striped orange and brown. The length averages 16 mm. The young are pale green with pinkish appendages, and often covered with a whitish powder. As they mature the appendages and thorax assume a blackish hue, while the abdomen becomes pale grayish brown. The eggs are somewhat three-sided, 1 mm. in diameter, pale or dark, shining brown, and laid singly or in masses of from 15 to 40 on the leaves and stems of the plants. The young and adults are very destructive feeders on cucurbitaceous plants, particularly gourds, squash, melons, and pumpkins, and are often responsible for the complete destruction of the vines. This bug is also apparently a carrier of the vine wilt disease, *Bacillus tracheiphilis* E. F. Smith.[1] In the west this species is a pest in New Mexico, Arizona, Colorado, California, and probably has a wider distribution. The western specimens are somewhat different in color from the eastern, but otherwise they are the same. The eggs are attacked by a number of parasites.[2] Control measures consist in clearing up and burning all refuse in the fields in late fall after harvest, clean culture, handpicking adults in the spring, dusting with cyanide dust; and spraying to kill the young with nicotine and soap as recommended for plant lice.

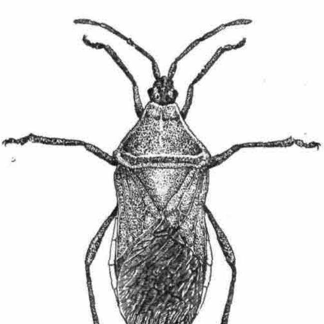

FIG. 224.—The squash bug, *Anasa tristis* (De Geer).

Andrew's squash bug, *Anasa andrewsi* (Guerin) (*Coreus*), is a neotropical species likely to be confused with the squash bug. Its food plants and habits are much the same. The color varies from yellowish brown to almost black and it is from 10 to 15 mm. in length. It ranges from Central America through Mexico into the Southern States and New Mexico.

CORIZIDÆ. Corizid Bugs.

The reflex plant bug, *Harmostes reflexulus* (Say), is variable in size and color. The length varies from 6 to 9 mm. and the color from yellow to green, and to almost bright red with paler or bright yellow markings. It is common in meadows, clover, and alfalfa fields, and is abundant throughout the United States. In the Western States it occurs in Colorado, Utah, Idaho, New Mexico, Arizona, and California.

The small bugs of the genus *Corizus* are common under the bark of trees where they hibernate in winter, and are often abundant in pastures, meadows, grass lands, and gardens during the summer. They frequently enter houses during the fall and winter.

[1] J. B. S. Norton, *Jour. Econ. Ent.*, 4, 1911, p. 272.
[2] L. O. Howard, *Proc. Ent. Soc. Wash.*, 1, 1888, p. 129.
A. A. Girault, *Ent. News*, 15, 1904, p. 337.

The variable grass bug, *Corizus crassicornis* (Linn.) (*Cimex*), is variable in size and color, so much so that no less than nine varieties are recognized. The average length is about 8 mm., and the color varies from a dark gray to a reddish brown, with the wing membrane noticeably whitish. It is a neotropical species ranging from Mexico to Canada. In the west it is often abundant in the grassy fields and is known in practically every State. **The hyaline grass bug,** *C. hyalinus* (Fabr.), is considerably smaller than the former being about 6 mm. long, pale or dark gray with reddish antennæ, legs, and wing veins. Five varieties are recognized in America and many others in Europe. It is common in grasses and feeds on alfalfa, barley, clover, evening primrose, lettuce, tomato, flowers, and weeds. This cosmopolitan species occurs in Europe, Asia, Africa, North and South America, and is known in Colorado, New Mexico, Arizona, Utah, Nevada, and California in the west. *C. scutatus* (Stål) is a reddish gray species, robust, 8 mm. long, which has been found in great numbers and injurious to garden plants in the San Francisco Bay region, California. It also occurs in Oregon, Utah, and Wyoming. *C. validus* Uhler is yellow or amber in color and 8 mm. long. It has been observed feeding on cotton bolls in Arizona,[1] and also occurs in Colorado, Wyoming, Utah, and California. It is thought to bite humans in Southern California.

The box elder bug, *Leptocoris trivittatus* (Say) (*Lygæus*)[2] (Figs. 217, 225), is a rather flat, elongated species varying from 10 to 14 mm. in length and

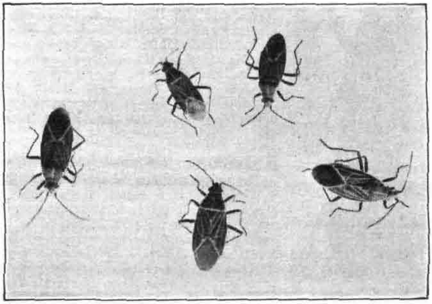

FIG. 225.—The box elder bug, *Leptocoris trivittatus* (Say).

from gray-brown to black with conspicuous red lines on the pronotum and hemelytra. The body is bright red with black head, black lateral markings, and black antennæ and legs. The red markings on the dorsum of the Rocky Mountain and eastern specimens are much more pronounced than on the extreme western forms. The young bugs are bright red and become marked with black when about half grown. The minute red eggs are laid in the cracks of the bark of the box elder trees in the spring by the hibernating adult females. The nymphs and adults normally feed on the foliage of the box elder and maples, but also often feed on the young, developing fruit of apples, cherries, grapes, peaches, and plums. The punctures cause dimples and deformations of the fruit, often entailing considerable loss in this way to the fruit growers. The adults hibernate about buildings and in hollow

[1] A. W. Morrill, *8th Ann. Rept.*, Ariz, Com. Agr. & Hort. 1916, p. 49.
[2] E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 204.

trees or other sheltered places, and often appear in immense swarms on sunny winter days on the trees and may invade residences much to the terror and dismay of the occupants. The species is strictly western, ranging from Kansas and Missouri to the Pacific Ocean and known in the west in Montana, Colorado, Utah, Arizona, New Mexico, California, Mexico, and Lower California. It probably has a greater western distribution. Control is best effected by destroying the hibernating adults when they appear in sufficient numbers. Spraying with a strong miscible oil spray or with kerosene readily kills all that are reached.

ARADIDÆ. Flat Bugs.

The members of this family are rather small oval, dark colored bugs which are exceedingly flat and are often mistaken for bedbugs. They normally live in the cracks and crevices or under the bark of living and dead trees and are predaceous in habits. Some feed on the branches of living trees. Because of their obscurity they are little known. *Aradus fuscomaculatus* Stål and *A. coarctatus* Heidemann range along the Pacific Coast from British Columbia through California; A. *behrensi* Bergroth occurs in Oregon, California, and Nevada; *A. duzeei* Bergroth in California, Colorado, and Eastern States; *A. hubbardi* Heidemann and *A. debilis* Uhler, a large brown species, throughout the west from the Rocky Mountains to the Pacific Ocean, and from British Columbia to Mexico; *A. lugubris* Fallén throughout North America and is common in the west. *Mezira mœsta* Stål (Fig. 226) is a dull black form known in British Columbia, Wyoming, California, and Arizona.

FIG. 226.—The flat bug, *Mezira mœsta* Stål.

NEIDIDÆ (*Berytidæ*). Stilt Bugs.

The mutic stilt bug, *Neides muticus* (Say) (*Berytus*), is a very slender, brown species with long, slender legs and antennæ. It formerly was supposed to be a plant feeder, but is now known to be predaceous on leafhoppers including the sugar beet leafhopper and other small insects. It occurs throughout North America and is known in most of the Western States from British Columbia to Lower California.

The spined stilt bug, *Jalysus spinosus* (Say) (*Berytus*), is a very slender, pale brown, mosquito-like bug, 6 mm. long, with longer, slender legs and knobbed antennæ. It is a plant feeder and prefers solanums, particularly tomatoes, potatoes, and horse nettle. It punctures the stems and ovaries of tomato plants causing the flowers and young fruit to dry up or to fall, much as does the late blight of tomato. The true form is eastern in distribution ranging west as far as Colorado. The variety *wickhami* Van Duzee is the western representative found in Oregon, California, Arizona, and Utah.

LYGÆIDÆ.[1] Chinch Bugs, Plant Bugs.

The spotted milkweed bug, *Oncopeltus fasciatus* (Dallas) (*Lygæus*) (Fig. 227), is a beautiful medium-sized bug rather slender, varying from 10 to 15 mm. in length, orange or bright red with three large black areas on the dorsum and black spots on the underside. The antennæ, rostrum, legs, and wing membranes are also black. The young are bright red with black appendages. The small, elongated eggs are bright red and have three

[1] H. G. Barber, "Synoptic Keys to the *Lygæidæ* of the U. S." *Psyche*, 24, 1917, p. 128.

down-curving chorial processes near the tip. The species feeds and breeds on various species of milkweed (*Asclepias*) and often becomes very abundant. Adults hibernate on trees and around buildings and often appear in great numbers on warm winter days much like the box elder bug. No damage to cultivated crops is yet ascribed to it, although it has been observed on many forage and garden plants. It ranges from Brazil to Canada,

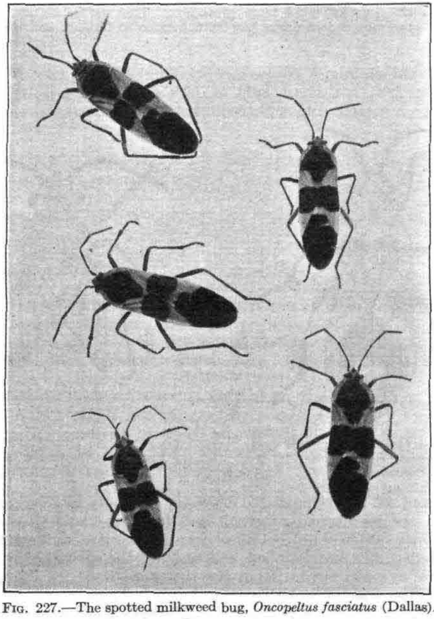

FIG. 227.—The spotted milkweed bug, *Oncopeltus fasciatus* (Dallas).

but is reported in the west only in California and Arizona. It probably occurs in some of the neighboring States as well.

The common milkweed bug, *Lygæus reclivatus* Say (Fig. 228), is smaller than the preceding, averaging from 9 to 11 mm. in length. The head, thorax, appendages, and spots on the abdomen are velvety gray-black, while the abdomen and marks on the dorsum are bright red. The wing membranes are black with white margins, white basal, and two characteristic median white spots. The nymphs are red and black. Like the former, this bug feeds on various species of milkweed (*Asclepias*), and though hibernating adults are often observed in large numbers it has no economic importance. It ranges

from Central America northward to Canada and is common throughout the Western States. *L. truculentus* Stål is almost identical with the preceding but has all of the colors very much dulled and faded. It occurs in California. *L. kalmi* Stål lacks only the two white spots in the wing membranes and has much the same distribution as *L. reclivatus* Say. *L. bicrucis* Say is 8 mm. long, bright red with black head, rostrum, antennæ, prothorax, legs, scutellum, and wing membranes. The membranes may be spotted white. The venter of the thorax is yellowish with black markings and the abdomen is bright red with small black specks. The bright red markings on the hemelytra are bordered on the inside with yellow. Narrow frontal and median yellow lines also occur on the dorsum of the black prothorax. This species occurs on California sage in California, but is a common bug from Mexico to Canada and throughout the west.

The false chinch bug, *Nysius ericæ* (Schilling) (*Heterogaster*, *N. angustatus* Uhler)[1] (Fig. 229), is a small, light or dark gray species, 3 to 4 mm. long. The nymphs are pale gray with reddish brown abdomen and match the

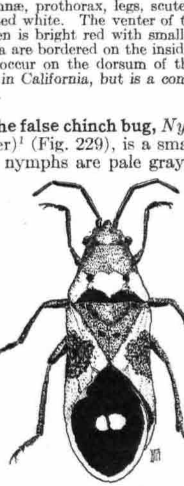

FIG. 228.—The common milkweed bug, *Lygæus reclivatus* Say. (After Woodworth.)

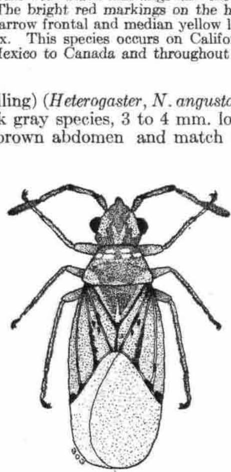

FIG. 229.—The false chinch bug, *Nysius ericæ* (Schilling).

dry weeds and soil to a remarkable degree. This very interesting and often destructive species normally breeds and feeds in the native grasslands where it multiplies in countless numbers. In the late summer and fall of the year, September and October, and again in the spring, May and June, the wingless nymphs swarm from the dry grasslands into the adjoining cultivated areas and infest all green and growing plants and soon do great damage. Maturity is soon reached after the spring swarming and the eggs are laid in cracks in the soil or on grasses, weeds, and so forth, during the entire summer from May to October, there being from four to seven broods a year. The winter is passed in the egg, nymph, and adult stages, but in the west the nymphal stage greatly predominates. The most serious injury occurs in the warmer and dryer regions where summer crops are produced by irrigation. Alfalfa, clover, grains, grasses, and other forage crops, truck crops, sugar beets, cotton, grapevines, fruit trees and young fruit, berries,

[1] E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 207.
F. B. Milliken, *Jour. Agr. Research*, 13, 1918, p. 571.

native flowers, and weeds are commonly infested and often destroyed. The bug has a wide distribution throughout North America and is common in Washington, Idaho, Oregon, California, Nevada, Utah, Montana, Colorado, Arizona, and New Mexico. Two varieties, *minutus* Uhler, a small form and *niger* Baker, a darker form, are recognized. Control measures consist in burning over or cultivating the adjoining grasslands and pastures, in frequently cultivating the invaded areas when the nymphs are swarming over the land, flooding or thorough irrigation where possible, and the free use of nicotine and soap sprays as recommended for aphis, or dusting with a 25% calcium cyanide.

The California false chinch bug, *Nysius californicus* Stål, is a very much longer species 5 to 6 mm. long, and more robust, but of the same pale gray color. It occurs in grasses and weeds, but rarely injures field, forage, and truck crops. It occurs throughout the west. A variety, *alabamensis* Baker, which is smaller and darker inhabits the Southern and Eastern States.

The chinch bug, *Blissus leucopterus* (Say) (*Lygæus*),[1] is the most famous member of the entire order because of the serious injury it causes to the wheat crop of North America. The adults are small, only 3 to 4 mm. long, rather slender, black, with the base of the antennæ and the legs reddish or yellowish brown. The wings may be very greatly abbreviated, covering only the base of the abdomen, in which case they are brown with white tips, or the wings may extend to the tip of the abdomen and be entirely white with a few basal brown lines and two median marginal brown spots. The nymphs are pale and dark brown with the abdomen dark reddish with dark spots, there being four instars of varying colors. The tiny eggs are elongate, oval, slightly curved, pointed at one end and blunt at the other, less than 1 mm. long, whitish when just laid and changing to amber and dark red before hatching. The winter is passed in the egg, nymphal, and adult stages in the warmer sections, but where the winters are hard only adults and a very small percentage of nymphs survive. These secrete themselves in thick grasses or under weeds and litter which are available. The eggs are laid in the soil or glued to the roots, stems, and leaves of grasses and grains; from 100 to 200 are laid by a single female. They hatch in from 10 to 30 days and the young mature in from two to three months. There are two generations annually. The fully winged adults are able to fly long distances; the short-winged forms and nymphs crawl, but move rapidly when food becomes scarce. The bugs injure the growing grain by sucking the juices and causing a withering and drying up of the plants. Where enormous numbers are present the entire crop may be ruined. The chief injury is to wheat, barley, rye, corn, and sorghum, but oats, grasses, millet, and similar crops are also attacked.

The greatest injury by the chinch bug is in the middle wheat-growing States and northward into Canada. It crosses the Rocky Mountains into Montana, Wyoming, Colorado, Oregon, Washington, Arizona, and New

[1] F. M. Webster, Bul. 15 n. s. Div. Ent. U. S. Dept. Agr. 1898. Bul. 69 Bur. Ent. U. S. Dept. Agr. 1907. *Farmers' Bul.* 657, U. S. Dept. Agr. 1915.
T. D. A. Cockerell, Bul. 35, N. Mex. Agr. Exp. Sta. 1900.
T. J. Headlee, Bul. 191, Kan. Agr. Exp. Sta. 1913.
E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 208.
J. R. Parker, *Jour. Econ. Ent.*, 13, 1920, p. 318.

Mexico, and has been known in various parts of California since 1885. Its rôle in the west is entirely different from that east of the Rocky Mountains, for while it is often present it is seldom sufficiently abundant to cause serious damage. By far the most important natural enemy in the east is the chinch bug fungus, *Beauveria (Sporotrichum) globulifera* (Speg.) Picard., which kills both immature and adult bugs, but as it thrives only in cool, wet seasons, it cannot be relied upon every year. The egg parasite, *Eumicrosoma benefica* Gahan, is reported from Kansas.[1] Predaceous bugs, beetles, and chrysopids also prey on the nymphs and adults. Control measures consist in destroying hibernating bugs by plowing or rolling the stubble after harvest, burning grasses, brush, weeds, and rubbish about fields and along fences and creeks in the late fall and winter, the use of trap crops which are destroyed with the bugs, immune crops in rotations, and the chinch bug fungus referred to above.

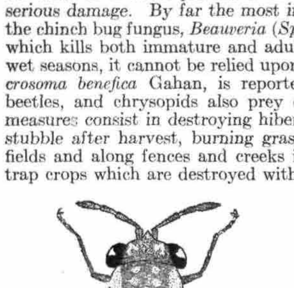

FIG. 230.—The big-eyed bug, *Geocoris pallens* Stål.

The western chinch bug, *Blissus occiduus* Barber,[2] is black, 3 mm. long, with short hemelytra and generally smaller than the typical western form of the chinch bug. It is reported in British Columbia, Colorado, and New Mexico.

The big-eyed bugs of the genus *Geocoris* are usually common in the grain and alfalfa fields. They are small, 3 to 4 mm. long, with head, thorax, and abdomen of the same width, and large compound eyes. *G. bullatus* (Say) is common about the roots of grasses and weeds in California, Utah, and Colorado (U. S.). *G. pallens* Stål (Fig. 203) is common in the alfalfa and sugar beet fields of California and occurs also in Arizona, New Mexico, Colorado, and Utah (U. S.). Dr. H. H. P. Severin has observed it feeding on *Eutettix tenellus* (Baker) in California. The two varieties, *decoratus* Uhler and *solutus* Montandon, are recognized. *G. punctipes* (Say) is also common on alfalfa in California, Arizona, New Mexico, and Colorado (U. S.).

PYRRHOCORIDÆ. Red Bugs, Stainers.

The bordered plant bug, *Euryophthalmus convivus* (Stål) (*Largus*) (Fig. 231), is a common, conspicuous bug in the Western States. It is large, 12 to 15 mm. long, the males being much narrower than the females. The body, antennæ and legs are black; the basal joint of the antennæ and the coxæ, trochanters and bases of the femora of the legs are red. The tip of the abdomen is brownish red. The dorsum is black; the posterior and basal lateral margins of the prothorax, the margins and numerous fine specks of the hemelytra are orange. The nymphs are broadly oval or nearly circular, convex, and bright metallic blue with a conspicuous red spot at the base of the abdomen. This bug is often very numerous on berry plants in the spring and summer, and punctures and feeds on the drupelets causing them to shrivel and dry up. The injury is chiefly to blackberries, loganberries, and strawberries. The writer has observed great numbers of the young and adults on lupine and other plants. The adults hibernate and are often common on warm winter days taking a sun bath. The species extends from Mexico into California and is common as far north as the San Francisco Bay region. *E. succinctus* (Linn.) (*Cimex*), is much like the preceding but lacks the fine

[1] J. W. McColloch, *Jour. Econ. Ent.*, 7, 1914, p. 219.
[2] H. G. Barber, *Bul. Brooklyn Ent. Soc.*, 13, 1918, p. 36.

orange specks on the dorsum. It is primarily an eastern species known in Colorado and Arizona in the west, and has often been confused with the other species. The hosts include cotton, nightshade, and mesquite. *E. cinctus* (Herrich-Schæffer) (*Largus*) is much paler than either of the preceding, varying from pale ochre to orange brown, with the wing membranes whitish or pale brown instead of black, and is more slender. It has a wide distribution ranging from Central America through Mexico, New Mexico, Arizona, Colorado, California, Nevada, and Oregon. The egg parasite, *Hadronotus*

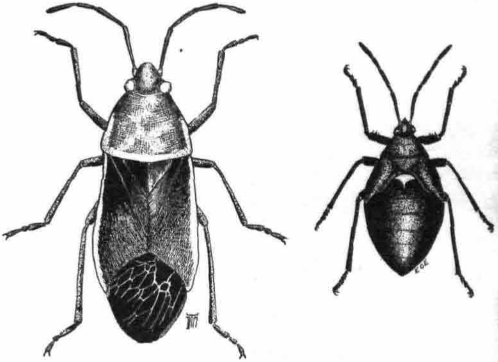

FIG. 231.—The bordered plant bug, *Euryophthalmus convivus* (Stål). Adult and nymph.

argi Ashmead, was probably reared from this species in Southern California rather than from *E. succinctus* (Linn.), as reported.[1]

The Arizona cotton stainer, *Dysdercus albidiventris* Stål, is 9 to 11.5 mm. long, colored a brilliant black, with red marks on head and shoulders, and yellowish hemelytra with 2 large black spots near the middle. In the nymphs red predominates. According to A. W. Morrill[2] this bug feeds on immature cotton bolls causing stained lint in the mature fibre. It is sometimes a serious pest in Arizona, and also attacks cotton in Imperial County, California, and in Texas and Mexico. *D. mimus* (Say) is black dorsally with red on head and shoulders of the prothorax, and a pale yellowish marginal line on the sides. It occurs in Mexico, Texas, New Mexico, Arizona, California, and Florida.

TINGIDÆ.[3] Lacebugs, Tingids.

The members of this family are small, flat, oval or rectangular with reticulated surface often lace-like in appearance. The head is frequently

[1] *Insect Life*, 4, 1891, p. 124.
[2] Bul. 87, Ariz. Agr. Exp. Sta. 1918.
[3] For spelling of family name see *Science* 56, 1922, pp. 334, 603, 754.
P. R. Uhler, "*Hemiptera* of Lower Cal." *Proc. Cal. Acad. Sci. Ser.*, 2, 4, 1894, p. 278.
H. Osborn and C. J. Drake, "*Tingitoidea of* Ohio." *Ohio State Univ. Bul.* 20, No. 35, Bul. 8, *Ohio. Biol. Surv.* 1916, p. 217. Also *Ohio Jour. Sci.*, 17, 1917, pp. 9, 295.
C. J. Drake, "N. A. Species of *Monanthia*." *Bul. Brooklyn Ent. Soc.*, 12, 1917, p. 49.

hidden beneath a large hood on the front of the greatly modified pronotum which also projects beyond the sides of the body. The abdomen is completely hidden by the wide, flat, lace-like hemelytra which are often transparent. The nymphs do not resemble the adults, being much darker and often covered with long body spines. All stages are plant feeders, usually occurring on the undersides of the leaves and producing quantities of small, dark pellets of excrement. They normally infest native plants, though occasionally they attack cultivated crops and ornamental shrubs and trees, but are seldom present in sufficient numbers to warrant control measures.

The apple lacebug, *Corythucha cœlata* Uhler, is 3.5 mm. long, translucent whitish, with the legs and rostrum reddish, the antennæ dusky, and the body black. The native host is unknown, but it has been taken on apple in California. It ranges also into Lower California.

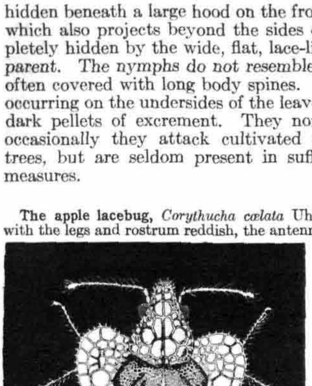

FIG. 232.—The western sycamore lacebug, *Corythucha confraterna* Gibson.

The sycamore lacebug, *Corythucha ciliata* (Say) (*Tingis*) is readily distinguished by its whitish color above and dark color beneath, and is 3.75 mm. long. This is the common tingid on many species of sycamores throughout North America, chiefly east of the Rocky Mountains, where it also occurs on ash, hickory, and paper mulberry. The western limits of distribution include Colorado and New Mexico. A spray composed of 6 pounds of whale oil soap. 1 pint of 40 per cent nicotine sulfate, and 100 gallons of water kills the young. The adults hibernate under the bark of the trees in winter and many can be reached with a dormant oil spray.

The western sycamore lacebug, *Corythucha confraterna* Gibson (Fig. 232), has often been mistaken as the western form of *C. ciliata* (Say), until set aside as a new species by E. H. Gibson.[1] It differs in having a white dorsum with many pale brown markings and is of smaller size, being but 3 mm. long. It occurs abundantly on the lower sides of the leaves of native and introduced sycamores in California, Arizona, and Mexico.

The cactus tingid, *Corythucha decens* (Stål) (*Tingis*), is 3 mm. long, yellow with brown band across apex and hemelytra and a median marginal brown spot on the latter. It ranges from Central America into Arizona and California, and feeds on the joints of cactus.

"N. A. Species of *Teleonemia*." *Ohio Jour. Sci.*, 18, 1918, p. 323. "New N. A. *Tingidæ*." *Ohio Jour. Sci.*, 17, 1917, p. 213; 19, 1919, p. 417; 20, 1920, p. 49.

W. L. McAtee, "Key to Nearctic Species of *Leptoypha* and *Leptostyla*." *Bul. Brooklyn Ent. Soc.*, 12, 1917, p. 55.

E. P. Van Duzee, "Cat. *Hemiptera* N. A." *Univ. Cal. Pub. Tech. Bul. Ent.*, 2, 1917, p. 209.

E. H. Gibson, "The Genus *Corythucha*." *Trans. Am. Ent. Soc.*, 44, 1918, p. 69. "The Genus *Gargaphia*." *Trans. Am. Ent. Soc.*, 45, 1919, p. 187.

[1] *Trans. Am. Ent. Soc.*, 44, 1918, p. 102.

The distinct lacebug, *Corythucha distincta* Osborn and Drake, is 4 by 2.41 mm., black, beneath, and dorsum yellowish gray with numerous reddish brown markings. It is a common western species known in Montana, Wyoming, Colorado, Utah, Washington, and California. It occurs on balsam root, beans, corn, lettuce, lupine, parsnip, squash, Canada thistle, turnip, and many native weeds.

The yerba santa lacebug, *Corythucha eriodictyonæ* Osborn and Drake, is 3.2 by 1.8 mm., black, and dorsum yellowish with brown and dusky markings. It commonly occurs on yerba santa in California.

The corn lacebug, *Corythucha essigi* Drake, is 2.8 by 1.5 mm., body black with the pronotum and hemelytra transparently white with very faint dark markings. This species has been taken on corn in Nevada County, California, but is not a pest. The native host has not been observed.

The prairie sunflower tingid, *Corythucha pura* Gibson, is 3.8 by 2.5 mm., body black, pale brown legs, pronotum and hemelytra transparent and without markings. It occurs on prairie sunflower in British Columbia and Washington.

The California Christmas berry tingid, *Corythucha incurvata* Uhler,[1] is 3.3 by 2.9 mm., body black, dorsum yellowish brown, due to brownish pronotum and faint brown band across apex, and a small brown spot at each front marginal angle of the hemelytra. The nymphs are dirty brown in color and entirely beset with short, stout spines. The eggs are shiny white, oval, 0.30 mm. long, with one end larger. The bases are inserted in a slit on the undersides of the leaves and the whole is covered with a brown sticky cement forming a cone-shaped mass over each egg. The nymphs and adults are often very abundant on the undersides of the leaves of the California Christmas berry and produce quantities of honeydew-like excrement which is covered with a black smut fungus. There are several broods a year, the adults hibernating under bark and leaves. Serious injury often results from the attacks which are only occasional. The species is limited to the range of the host in California and Arizona. Two other species, *C. heteromelecola* Drake and *C. bullata* Van Duzee,[2] also occur on the same host in California. The former has a shorter, and the latter a higher hood than *C. incurvata* Uhler.

The walnut tingid, *Corythucha juglandis* (Fitch) (*Tingis*), varies from 3.3 to 3.8 mm. in length, and from 2 to 2.3 mm. in width. The dorsum is yellow or pale brown, there being a distinct median, longitudinal, as well as an apical, brown band across the hemelytra. It feeds on walnut, butternut, basswood, and linden, and is recorded from British Columbia, Washington, Oregon, and Idaho in the west.

The goldenrod tingid, *Corythucha marmorata* (Uhler), is 3.2 by 1.8 mm., body black, antennæ and legs yellow, dorsum pale whitish with fine brown spots and four transverse brown lines on the hemelytra. It is a common eastern species on goldenrod, aster, chrysanthemum and related plants, and ranges west into Colorado, New Mexico, and California. It is frequently found in greenhouses.

The ceanothus tingid, *Corythucha obliqua* Osborn and Drake, is 3.45 by 1.44 mm., black body, dark brown hood and pale hemelytra with many small brown specks, transverse basal and apical brown band. It is common on ceanothus in the Sierra foothills of California and also occurs in Oregon and Idaho.

The choke cherry tingid, *Corythucha padi* Drake, is 3.8 by 2.4 mm., body black, legs and antennæ amber, dorsum whitish with fine brown specks and a dorsal and basal transverse brown band. It infests the leaves of the western choke cherry and is known to occur in British Columbia, Montana, Washington, and Oregon.

The alder lacebug, *Corythucha pergandei* Heidemann, is about 3 by 1.7 mm., body black, pale above with pale brown band across base and apex of hemelytra. It commonly infests alder but also occurs on crabapple, elm, sweet birch, and hazel in the Eastern States. The known western limits include New Mexico, Arizona, and California.

The western willow tingid, *Corythucha salicata* Gibson, is 3.4 by 2 mm., the dorsum whitish above with two brown spots on pronotum, a faint or obsolete brown band at base, brown at apex and a small brown spot at the center of the costal margin of the hemelytra. It occurs on willow and sparingly on apple in British Columbia, and also occurs in Oregon. **The eastern willow tingid,** *C. salicis* Osborn and Drake, is about the same size with the brown markings more pronounced. It is reported from Montana and British Columbia in the west and infests willows.

[1] C. Pemberton, *Jour. Econ. Ent.*, 4, 1911, p. 339. Wrongly determined as *Corythucha arcuata* (Say).

[2] C. J. Drake, *Ohio Jour. Sci.*, 20, 1920, pp. 50, 51.

The angulate tingid, *Gargaphia angulata* Heidemann, is rather slender, measuring 3.4 mm. by 1.6 mm. The body and legs are black, antennæ amber, pronotum blackish, hood and hemelytra hyaline with nervures amber, there being 3 or 4 black transverse nervures in the latter. It is an eastern and southern species often occurring on beans in the south. In New Mexico and Arizona it infests ceanothus.

The iridescent lacebug, *Gargaphia iridescens* Champion, is 3 by 1.2 mm., body black, antennæ black and yellow, legs brown with tarsi and claws black, dorsum whitish with yellow nervures. It infests many solanaceous plants, ragweed, and malva, and ranges from Mexico into Texas, New Mexico, Arizona, and California. *G. opacula* Uhler is practically the same as the preceding, being separated by a wider and more flaring margin of the pronotum and by a slight difference in the hemelytra. It is a native of the Southwestern States of Utah, New Mexico, and California, and feeds on egg plant, willow, and *Dahlia spinosa*. It has been reported as a pest to eggplant in New Mexico.[1]

The eggplant lacebug, *Gargaphia solani* Heidemann, is a large species 4 by 2 mm., body dark brown, antennæ dark and yellow, legs pale, nervures of pronotum and hemelytra yellow or pale brown. It occurs in the Southern States and ranges west into New Mexico and Arizona. It is a pest to solanums and is often injurious to horse nettle, eggplant, potato, and tomato. It also feeds on cassia, *Amphiachrus* sp., sage, and cotton.

The Arizona ash tingid, *Leptoypha minor* McAtee, is small, 1.80 by 0.85 mm., pale brown with darker brown dorsal markings and nervures. The nymphs are much the same color, very hairy and often covered with fine debris. This species is a serious pest on Arizona or Texas ash and poplars in the San Joaquin Valley, California. The nymphs and adults often become so thick as to entirely cover the surface of the undersides of the leaves. It occurs also on scarlet runner beans and is found throughout Arizona and California. According to W. L. McAtee,[2] "this species is very closely related to *L. brevicornis* Champion," a Mexican species ranging into Southern California. *L. costata* Parshley is recorded on ash and witch hazel in Colorado and Eastern States.

FIG. 233.—The jagged ambush bug, *Phymata erosa* (Linn.). Dorsal and lateral aspects.

PHYMATIDÆ. Ambush Bugs.

The jagged ambush, air-bush, or stinging bug, *Phymata erosa* (Linn.) (Fig. 233), is an odd looking bug, variable in length from 7–12 mm., fawn and pale brown with darker brown markings and a wide brown band across the middle of the abdomen. The thorax is spined and the front legs are for grasping and holding the living prey on which it feeds. It commonly inhabits flowers where it lies in wait for flower-visiting insects, feeding chiefly on honeybees, thus causing it to be regarded as a more injurious than beneficial insect. The eggs are oval, black, 1.6 mm. long, covered with a sticky secretion nearly to the neck; the apical cap is thin and flat. It ranges throughout the country and is common in the west. A number of subspecies are recognized: *fasciata* (Gray), throughout the whole country; *arctostaphylæ* Van D., *parva* Handl. and *severini* Handl., in California; *salicis* Ckll., in Arizona and Utah; *wolffi* Stål, ranging as far west as New Mexico.

[1] C. H. T. Townsend, *Can. Ent.*, 26, 1894, p. 314.
[2] *Bul. Brooklyn Ent. Soc.*, 14, 1919, p. 142.

REDUVIIDÆ. Assassin Bugs, Wheel Bugs, Soldier Bugs, Kissing Bugs, Pirate Bugs.

The members of this family run from medium to quite large size, oval in form with small, narrow head; sharp curved, 3-jointed, rigid rostrum; large bead-like eyes; ocelli present; long slender 4- or 5-segmented antennæ with the last segment filiform; and spiny, grasping or normal front legs. As the common names imply, these are voracious, carnivorous bugs which ambush or stalk their prey which when captured is held in the front legs and the juices sucked while struggling. They are chiefly diurnal and most abundant on plants, but some species are nocturnal and very active on warm summer nights. When interfered with they readily bite humans causing a poisonous wound which may be quite as painful as the sting of a bee, but usually no more severe. The food consists chiefly of plant lice, leafhoppers, bugs, caterpillars, butterflies, honeybees, and in fact any living thing small enough for them to overpower, so that while they kill many harmful insects, their usefulness is questionable because of the beneficial forms which they destroy quite as impartially.

The thread-legged bugs have very slender legs and bodies and are frail as compared with the true assassin bugs. *Ploiaria californiensis* Banks is wingless, dark brown,

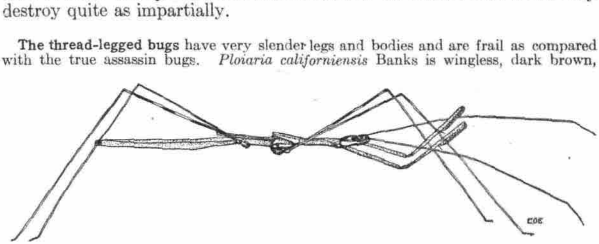

FIG. 234.—The thread-legged bug, *Emesa brevicoxa* Banks.

9 mm. long, the pronotum equaling the length of the head. It occurs in California *Ploiariola californica* (Banks) (*Ploiariodes*) is 5–6 mm. long, with brown-spotted wings. It is known in Oregon and California. *Ploiariopsis reticulata* Baker is dark brown, 9 mm. long, and the wings rather heavily reticulated with dark lines and spots. The head is longer than the prothorax. It occurs in Southern California. *Emesa brevicoxa* Banks (Fig. 234) is the largest and most abundant California species and often collects in large numbers in barns and sheds. It is 30 to 35 mm. long, brown with wings about one-third the length of the abdomen. The coxæ of the front legs are noticeably long, being more than twice as long as the head. The prothorax is not distinctly separated from the mesothorax. *Barce banksi* Baker is 10 mm. long, pale brown, with the head shorter than the prothorax which is distinctly separated from the mesothorax. It inhabits Southern California.

The western blood-sucking cone-nose, *Triatoma protracta* (Uhler) (*Conorhinus protractus* Uhler) (Fig. 235), is also known by various other common names, as big bedbug, China bedbug, and sacred bug. It is black throughout, from 16–19 mm. long. It is common throughout California and ranges east into Utah and south into Mexico. It frequently invades the beds of campers as well as residences and is often responsible for painful bites to humans, producing definite systemic disturbances and often a rather severe, but never fatal, illness. Some believe it to be a vector of a

Trypanosoma, not only among rats, but also from rats to man. Van Duzee[1] reports it common in the nests of wood rats.

The western corsair, *Rasahus thoracicus* Stål (Fig. 236), is one of the commonest species in California, Arizona, and Mexico. It is striking in appearance being rather slender and of a uniform amber color with black wing membranes. Near the middle of the membrane of each front wing is a conspicuous circular, amber spot. This species is chiefly nocturnal and is often quite numerous about street lights on warm summer evenings.

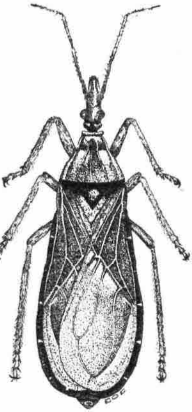

FIG. 235.—The western blood-sucking cone-nose, *Triatoma protracta* (Uhler).

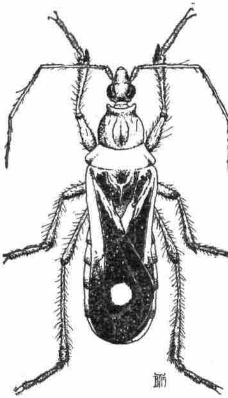

FIG. 236.—The western corsair, *Rasahus thoracicus* Stål. (Redrawn from Woodworth.)

When captured it makes a weird squeaking noise and inflicts a painful bite if allowed. Like many of its relatives, it bites usually only in self-defense.

The bee assassin, *Apiomerus crassipes* (Fabr.) (Fig. 237), is a robust black and ruby species 12–15 mm. long, and with thick down on the legs, head, and thorax. The tarsi of the front and middle legs are exceptionally small. This species is common in flowers and makes a practice of capturing honeybees, but also preys upon other visitants. It occurs throughout the west, being known in British Columbia, California, Nevada, Utah, Colorado, Arizona, as well as in much of the United States. *A. flaviventris* H. S. is a large bright red, yellow, and black species, ranging from Mexico north into Texas, Arizona, New Mexico, Colorado, and California. Nymphs and adults have also been observed feeding on honeybees.[2] *A. immundus*

[1] E. P. VanDuzee, *Trans. San Diego Soc. Nat. Hist.*, 2, 1914, p. 13. Also see W. B. Herms *Medical and Veterinary Entomology*, Macmillan Co., N. Y., pp. 90–95, 1923.

[2] D. W. Coquillett, *Insect Life*, 4, 1892, p. 343.

Bergroth appears to be but a darker form of the same species which occurs in Southern California and Mexico. *A. pictipes* H. S. is variable in color from black to brownish with red, yellow, or orange markings, and with the hind and most of the middle legs black. It is neotropical, ranging north

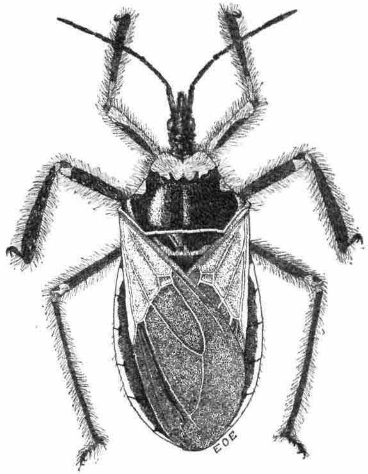

FIG. 237.—The bee assassin, *Apiomerus crassipes* (Fabr.)

into New Mexico and Colorado. *A. spissipes* (Say) is brownish and red, and ranges from Mexico into Texas, New Mexico, Colorado, and Arizona.

The leafhopper assassin bug, *Zelus socius* Uhler, is a slender brown or reddish species, 10–13 mm. long, with long, slender legs and antennæ. H. H. P. Severin has observed it feeding on the sugar beet leafhopper, *Eutettix tenellus* (Baker), in California. It is also reported in British Columbia, Idaho, Colorado, Utah, Arizona, and New Mexico, and undoubtedly occurs in the intervening territory.

The wheel bug, *Arilus cristatus* (Linn.), is a gigantic, brown species, 28 mm. long with cog-like teeth in a median longitudinal, hemispherical ridge on the thorax, and is common in the Eastern and Southern States, ranging west into New Mexico.

The spined or rapacious soldier bug, *Sinea diadema* (Fabr.)[1] (Fig. 238), is a pale buff or brown species 12 mm. long, distinguishable by the spined anterior prothoracic lobes and undulate margins of the female abdomen. The eggs are 1.5 mm. long, cylindrical, rounded at bottom and truncate at

[1] A. N. Caudell, Key to Genus *Sinea*. *Jour. N. Y. Ent. Soc.*, 9, 1901, p. 3.

top, surmounted by a white marginal fringe around a cone-shaped cap. They are laid in groups of 8 to 10 and held together and covered with a

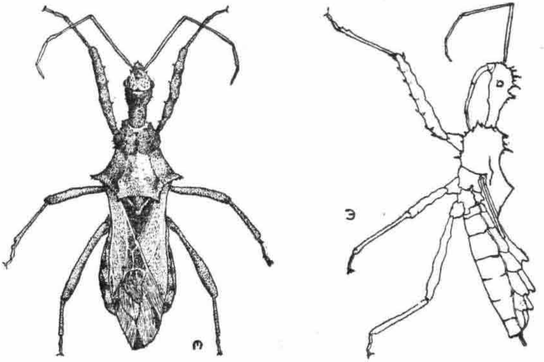

FIG. 238.—The spined soldier bug, *Sinea diadema* (Fabr.). (After Quayle.)

reddish yellow secretion. This bug is largely beneficial and feeds on caterpillars, grubs, and the larvæ of many injurious insects. The distribution embraces the entire country; it is found in practically all of the Western States. There are a large number of related species in the west.

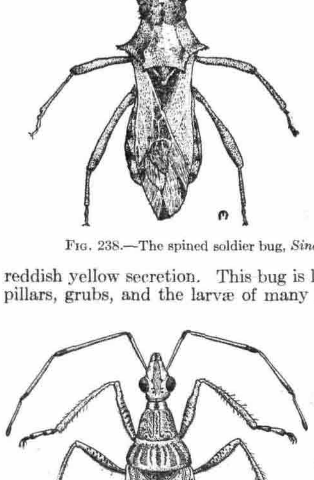

FIG. 239.—The common damsel bug, *Nabis ferus* (Linn.).

NABIDÆ. Damsel Bugs.

The common damsel bug, *Nabis ferus* (Linn.) (Fig. 239), somewhat resembles a small assassin bug because of the shape and raptorial front legs. The adults average 8 mm. in length and are pale gray in color with 4-segmented antennæ and rostrum. This is the commonest member of the family and occurs throughout Central and North America, and in every Western State. It inhabits fields and orchards, and preys extensively on aphis, leafhoppers, treehoppers, and small caterpillars. A number of other unimportant species are also reported in the west.

CIMICIDÆ. Bedbugs.

The bedbugs are well known domesticated insects which have accompanied the human race to all parts of the world and still attend man in spite of the strong objections of the latter. These specialized bugs are small, oval, flat, tough, wingless or with wing stubs, dark brown in color, with large compound eyes and no ocelli, and with 4-segmented antennæ, 3-segmented tarsi, and 3-segmented rostrum. The latter rests in a groove beneath the head and prothorax. They are nocturnal and feed on the blood of warm-blooded mammals and birds. The females lay from 50 to 200 yellowish white, oval, sculptured eggs in the cracks of buildings, furniture, and so forth. The eggs hatch in from five to ten days and the nymphs undergo five molts in reaching maturity in about two months. One meal is required between each molt. They possess a bad odor which adds to their offensiveness. They are also thought to be carriers of certain dreaded diseases.

The common bedbug, *Cimex lectularius* Linn.[1] (Fig. 240), is brown, rust-red or purplish in color, oval, flat, and 4–5 mm, in length. It is the species

FIG. 240.—The common bedbug, *Cimex lectularius* Linn., feeding on the back of a finger. (Photo furnished by S. B. Doten.)

most often found in cheap rooming houses, hotels, and residences throughout the world, but is rather uncommon in the Western States as compared with other sections of this country. It invades the beds at night and attacks the sleepers. Its presence may be determined by examining the ticks and bedding for the characteristic dark stains of excrement and the familiar odor. It is most effectively controlled by heavy fumigations with hydrocyanic acid gas. **The bat bug,** *C. pilosellus* (Horvath), infests bats in British Columbia, California, Arizona, Colorado, and Eastern States. **The barn swallow bug,** *Œciacus vicarius* Horv. (*Acanthia hirundinis* Gillette and Baker), looks much like a bedbug, but is clothed with long, silky hairs, and infests swallows and poultry in California, Colorado, Mexico, and the Eastern States. **The poultry bug, coruco, or Mexican chicken bug,** *Hæmatosiphon inodorus* (Duges) (*Acanthia*),[2] also resembles a bedbug, but has

[1] C. L. Marlatt, *Farmers' Bul.*, 754, U. S. Dept. Agr. 1916

[2] C. H. Townsend, *Proc. Ent. Soc. Wash.*, 3, 1893, p. 40.
T. D. A. Cockerell, *Insect Life*, 7, 1894, p. 210.

longer legs, is more active, and lacks the odor. The rostrum is very much longer, reaching to the hind coxæ, and the eyes touch the pronotum. It primarily infests poultry and may completely overrun the roosts and nests. It also invades dwellings where it may prove more serious to humans than the bedbug. It is an inhabitant of hot, dry regions, and is known in Mexico, Texas, and New Mexico. The difficulty of control is emphasized in the fact that the Indians and Mexicans often either abandon or burn their houses to kill the bugs. Fumigation as for the common bedbug, however, exterminates them effectively.

ANTHOCORIDÆ. Minute Pirate Bugs.

The aphis killer, *Anthocoris antevolens* White, is small, 3–4 mm. long, flat, ovate, head long, prominent compound eyes and ocelli, 4-segmented antennæ, and 3-jointed rostrum. The color is brown with the bases and tips of the hemelytra transparent. The nymphs are reddish and often occur in the galls of various aphis upon which they

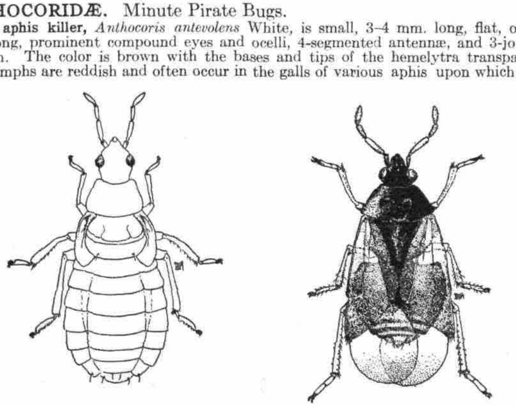

FIG. 241.—The dark triphleps, *Triphleps tristicolor* White. Nymph and adult. (After Quayle.)

prey. It is known in Montana, Colorado, and California. *A. melanocerus* Reuter occurs in British Columbia, California, Utah, and Colorado. **The dark triphleps,** *Triphleps tristicolor* White (Fig. 241), is a minute black species 1.5 mm. long, with three white marks on the back due to the transparent bases and tips of the hemelytra. The nymphs are amber. All forms are abundant on the leaves and in the flowers of plants, and prey on mites, thrips, aphis, young scales, and other minute forms. It is common in the west and is known in Oregon, California, Nevada, Idaho, Colorado, and Arizona. The eastern species, *T. insidiosus* (Say), is much like this species, but ranges only as far west as Colorado.

MIRIDÆ (*Capsidæ*). Leaf Bugs, Plant Bugs.[1]

The members of this very large family are among the commonest bugs. They are small, fragile, elongate or oval, head distinct with prominent

[1] H. M. Parshley, "*Miridæ* Taxonomy." *Ent. News*, 26, 1915, p. 208.
E. P. Van Duzee, "Key to Genera of N. A. *Miridæ*." *Univ. Cal. Pub. Tech. Bul.* 1, No. 3, 1916, p. 199.
H. H. Knight, "Family *Miridæ*." Bul. 34, *Conn. Geol. and Nat. Hist. Surv.*, 1923, p. 422.

compound eyes and the ocelli absent, rostrum and antennæ 4-segmented, tarsi 3-segmented, the hemelytra are usually well developed, but brachypterous forms are not uncommon. The wings have a well developed cuneus and two cells, and a longitudinal vein in the membrane. They are active, run fast, and fly freely. The majority are plant feeders and many of them destructive pests, but a large number are predaceous on other insects. There are so many species that only a few of the important western forms are included.

The black grass bug, *Irbisia solani* (Heid.)[1] (Fig. 242), is a small species only 5 mm. long. The color is shining black, the legs reddish brown or with black femora. It often breeds in great numbers in the native vegetation such as grasses, wild radish, mustard, and weeds. When these begin to dry up the bugs migrate into the nearby cultivated fields and gardens and destroy almost everything available, such as artichoke, barley, buckeye, cucumber, lettuce, oats, onion, peach, plum, prune, potato, radish, rose, rhubarb, and wheat, causing pale yellow spots to appear on the plants or killing them. The species occurs in Washington, Oregon, California, Nevada, Utah, Colorado, and New Mexico. The use of 25 per cent calcium cyanide dust is the best means of control. It has previously been mistaken for *I. brachycerus* (Uhler), a similar species in Colorado. **The California plant bug,** *I. californica* Van Duzee, is also a polished black species with reddish legs, 7 mm. long, and much larger than the former. It also feeds on grasses and grains in early summer and ranges along the coast from San Francisco Bay to Southern California. *I. mollipes* Van Duzee is polished black with reddish legs, 5.5 mm. long, infesting grasses from Marin County, California, to New Mexico. *I. setosa* Van Duzee is 5–6 mm. long, polished black with reddish pubescence. It infests grasses in Central California. *I. sericans* (Stål) inhabits Alaska.

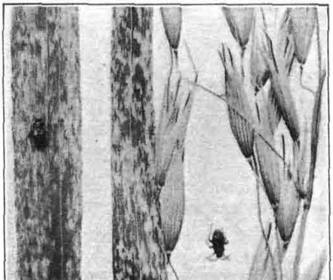

FIG. 242.—The black grass bug, *Irbisia solani* (Heid.), and characteristic work on oats.

The Pacific grass bug, *Irbisia pacificus* (Uhler) (*Thyrillus*), is 7 mm. long, grayish black, easy separated by the gradual enlarging of the body posteriorly until very

[1] E. P. Van Duzee, "A Study of N. A. Grass Bugs of the Genus *Irbisia*." *Proc. Cal. Acad. Sci.* (4), 11, 1921, p. 145.

near the tip where it rounds off. In infests grasses and grains in British Columbia, Washington, Oregon, California, Idaho, Montana, and Nevada.

The superb plant bug, *Adelphocoris superbus* (Uhler) (*Calocoris*), is blackish with orange or yellow sides, the nymphs being green with brown markings. According to C. H. T. Townsend[1] it has been quite injurious to alfalfa in New Mexico. It also occur in Arizona, Colorado, and Utah.

The tarnished plant bug, *Lygus*[2] *pratensis* (Linn.) (Figs. 217, C; 243, 244), is the commonest species throughout North America and occurs in all of the Western States. It varies from pale green to yellowish or dark brown, marked with yellow, black, and sometimes red. The length averages 6 mm. The nymphs are pale yellow or green. Four varieties are listed. The winter is passed in the adult stage, activity and feeding continuing throughout the entire year in the warmer States. In early spring the females, by means of the ovipositor, insert the eggs into the plant tissues, partially or entirely under the epidermis. In the leaves the eggs are usually placed in the midribs or partially imbedded between the veins, often causing minute swellings. In the stems they are buried in the tissues flush with the surface. The young begin to feed shortly after hatching. The species is very prolific and often does serious damage because of the great numbers. It pierces the tissues and extracts the juices, causing the plants to turn yellow, retarding, if not altogether stopping, growth. The very young fruit of apples are sometimes punctured in egglaying, causing dimples to develop in the mature fruit.[3] In feeding, gumming is produced on the fruit of peaches in Colorado. According to R. H. Smith it often injures the seed of alfalfa causing it to shrivel and dry up in the hulls in Idaho where it also feeds on the fruit of strawberries and raspberries. E. J. Newcomer has observed it attacking fruit hanging in alfalfa used as a cover crop in Washington. In British Columbia it is often quite serious to nursery stock causing the leaves to curl and the buds to drop. In Utah and Idaho it has injured potatoes causing the tops to wilt and die. In California and Arizona it attacks and injures cotton squares.[4] It attacks all kinds of flowers, grasses, fruits, field crops, truck crops, and weeds. H. P. Barss suspects it of carrying cherry gummosis in Oregon. In Virginia it attacks the terminal buds of peaches causing a trouble known as "stop-back of peach,"[5]

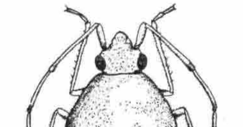

FIG. 243.—The tarnished plant bug, *Lygus pratensis* Linn.). (After Woodworth.)

[1] *Can. Ent.*, 24, 1892, p. 193.

[2] H. H. Knight, *Rev. of Genus Lygus in N. A. North of Mexico.* Bul. 391, Cornell Univ. Agr. Exp. Sta. 1917.

[3] E. P. Taylor, *Jour. Econ. Ent.*, 1, 1908, p. 370.

[4] A. W. Morrill, *Jour. Econ. Ent.*, 10, 1917, p. 310.

[5] E. A. Back and W. J. Pierce, Jr. *Jour. Econ. Ent.*, 5, 1912, p. 329.

and produces a similar effect on peaches in Missouri.[1] The only parasite reported in the United States is *Anagrus ovijentatus* Crosby and Leonard,[2] which was reared from the eggs in New York. Control measures are practical only when the bug concentrates its attacks, at which time it can be effectively killed by dusting with 25 per cent calcium cyanide. *L. elisus* Van Duzee also occurs on cotton in Arizona and California. *L. sallei* Stål is smaller and more shining than the tarnished plant bug, but is quite as common in parts of California. It also ranges in Arizona, New Mexico, Colorado, Texas, and Mexico, and feeds on baccharis and a great many native shrubs. *Deræocoris brevis* Uhler (*Camptobrochis*) is a small black bug 4 mm. long, with pale whitish nymphs marked with black. It is a

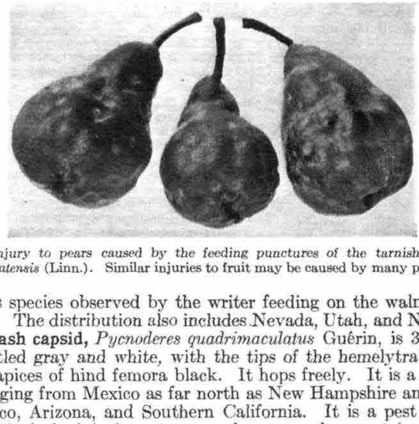

Fig. 244.—Injury to pears caused by the feeding punctures of the tarnished plant bug, Lygus pratensis (Linn.). Similar injuries to fruit may be caused by many plant bugs.

predaceous species observed by the writer feeding on the walnut aphis in California. The distribution also includes Nevada, Utah, and New Mexico.

The squash capsid, *Pycnoderes quadrimaculatus* Guérin, is 3 mm. long, black mottled gray and white, with the tips of the hemelytra white, legs pale with apices of hind femora black. It hops freely. It is a neotropical species ranging from Mexico as far north as New Hampshire and west into New Mexico, Arizona, and Southern California. It is a pest to cucurbs and is particularly injurious to cucumbers, cassaba, cantaloupes, muskmelon, squash, and watermelon, but also feeds on beans, lettuce, other garden vegetables, and weeds.[3] It is also known as the cucumber, melon, or cassaba bug. **The garden flea hopper,** *Halticus citri* (Ashmead), is 1.5 to 2 mm. long, black with grayish pubescence, giving a silvery appearance, and with pale markings on the antennæ and legs. The female is usually brachypterous. It is eastern and southern in distribution, recorded in the west only in Utah. It feeds on beans, chrysanthemum, clover, cowpea, morning glory, pea, plantain, smilax, sugar beets, and weeds. *Hadronema militaris* Uhler is 5 mm. long, black and red, feeding normally on wild

[1] L. Haseman, *Jour. Econ. Ent.*, 6, 1913, p. 237.
[2] C. R. Crosby and M. D. Leonard, *Can. Ent.*, 46, 1914, p. 181.
[3] T. D. A. Cockerell, Bul. 32, Ariz. Agr. Exp. Sta. 1899, p. 28.
A. W. Morrill, *Jour. Econ. Ent.*, 6, 1913, p. 190. Also 8th *Ann. Rept.* Ariz. Com. Agr. and Hort., 1916, p. 44.

indigo, but is reported on alfalfa in New Mexico. It also occurs in Colorado, Utah, Wyoming, California, and Eastern States. *Rhinocloa forticornis* Reuter is black or brown, variegated yellow or silver, and feeds on scrub oak and alfalfa in New Mexico.[1] It also occurs in California, Utah, and Texas.

The ash bug, *Neoborus illitus* Van Duzee, is a small brown and yellow species which has been taken in large numbers on the Oregon ash in Middle and Northern California.

GERRIDÆ. Water Striders.

The common water strider or skater, *Gerris remigis* Say (Fig. 245), is the familiar insect inhabiting the slack, shady places on the surface of freshwater streams, lakes, and ponds, and walks on the water. The bodies are long and slender, averaging 20 mm. in length, brown with long, stilt-like legs, the first pair reduced in size for catching and holding the living insects upon which it feeds. It is distinguished from other bugs in having the claws situated some distance from the tip of the last tarsal segment. The adults are winged or apterous and hibernate under rocks and logs near the water and lay their eggs in single rows on the undersides of floating leaves of aquatic plants and on water grasses. The life cycle requires about seven weeks, the young passing through five molts. It is widely distributed throughout Central and North America and probably occurs in all the Western States, although actually recorded from Oregon, California, Arizona, New Mexico, and Colorado. The eggs are parasitized by an aquatic hymenopterous insect, *Limnodites gerriphagus* Marchal,[2] and the nymphs and adults are preyed upon by the young of a red mite, *Limnochares* sp., which attaches itself to the head of the insect. *G. orba* Stål is likely to be confused with the preceding. It is about the same size, but usually darker in color. It is a western species recorded from Oregon, California, Nevada, and Utah. *G. marginatus* Say is only about half as large as the former and is mostly winged in the adult stage. It covers the United States and Canada and is known in British Columbia, Oregon, California, and Colorado in the west. *G. buenoi* Kirkaldy is also a small species frequently confused with the preceding and apparently ranging from British Columbia to the Eastern States, although only reported in the west from British Columbia and Colorado. *G. gillettei* Lethierry and Severin is also a western species occurring in California, Utah, Montana, and Colorado. It is reported on brackish water in the latter.[3]

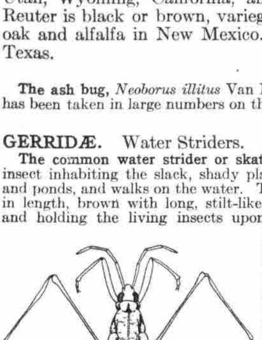

FIG. 245.—Nymph of the common water strider or skater, *Gerris remigis* Say. (After Woodworth.)

VELIIDÆ. Veliids.

The American veliid, *Microvelia americana* (Uhler), is a small, flat, dull black species with pale brown legs, 2.5 mm. long, which frequents the edges of streams, lakes, and ponds, and which runs swiftly on land or water. Like the other members of the family, it is predaceous on various small insects. The adults hibernate in debris. The eggs are laid in gelatinous masses in damp places. There are five molts and four or five broods a year. This species is generally distributed throughout North America and is the commonest form in California. It also occurs in Colorado and New Mexico in the west. *M. horni* Uhler ranges in California, Arizona, New Mexico, and Colorado.

[1] C. H. T. Townsend, *Can. Ent.*, 24, 1892, p. 194.
[2] R. Matheson and C. R. Crosby, *Ann. Ent. Soc. Am.*, 5, 1912, p. 67.
[3] J. R. De La Torre-Bueno, *Ent. News*, 24, 1913, p. 21.

SALDIDÆ. Shore Bugs.

The littoral shore bug, *Salda littoralis* (Linn.), is a common representative of this family. The adults are small, 5 mm. long, oval, shining black, and are capable of moving quite rapidly. They frequent damp and wet areas in marshes, near the shores of streams and ponds. They are predaceous in habits. This species ranges over Europe and North America and is reported from California and Utah in the west. *Lampracanthia coriacea* Uhler (*Salda*) is a shining black species with the bases of the hemelytra wider than the prothorax. It ranges from northern Canada southward, extending in the west to British Columbia, Colorado, and Utah. *Saldula interstiatialis* (Say) is a small, dark species with the hemelytra partially transparent and spotted. It has a wide range in North America and is probably the commonest western species, being reported from British Columbia, Idaho, Colorado, New Mexico, and California. *S. pallipes* (Fabr.) is somewhat pale with brownish spots on the margins of the hemelytra. It is palæarctic ranging in the west from Alaska to California, Nevada, Utah, Colorado, and New Mexico.

NOTONECTIDÆ. Back Swimmers.[1]

These are the well known back swimmers, aquatic insects which have the hind pair of legs developed for swimming and swim upside down. They are small to medium-sized, with well developed wings which are used for night flying, and are carnivorous in habits, feeding on insects, tadpoles, small fish, and other aquatic animals. They are frequently serious menaces to young fish in hatchery pools and are at times troublesome in swimming pools, biting the bathers. The eggs are laid on or inserted in the leaves and stems of aquatic plants and are often parasitized by *Caraphractus cinctus* Walker.[2]

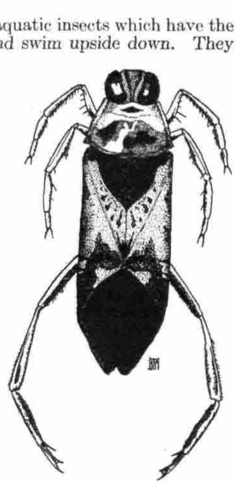

FIG. 246.—The large back swimmer, *Notonecta insulata* Kirby. (After Woodworth.)

Notonecta undulata Say[3] is the most widely distributed species ranging from North to South America and occurring in practically every Western State. It is 10–13 mm. long and varies in color from white to black, but western specimens are mostly pale. It lays the elongated white eggs, 1.9 to 2 mm. long, on or inserted in the stems of aquatic plants. There are five molts and at least two broods a year. All forms feed on young *Entomostraca* and insects. It must be a great night flyer since a pool built by the writer and filled with water in the evening had at least half a dozen of these insects in it the next morning. Six varieties are listed by Van Duzee. *N. insulata* Kirby (Fig. 246) is the largest species averaging 12–16 mm. in length. The color is variable, fuscous, greenish white and luteous, marked with black. It occurs throughout the entire western area from British Columbia to Lower California, and Montana to New Mexico. Three varieties have been named. *Notonecta indica* Linn. is also a common and abundant western species. It averages 10 mm. in length and is bluish black to brownish violet in color. The eggs are attached to water plants and are laid in such great numbers

[1] J. R. De La Torre-Bueno, "Keys of American *Notonectidæ* North of Mexico." *Jour. N. Y. Ent. Soc.*, 13, 1905, p. 143. Also Bul. 34, *Conn. Geol. and Nat. Hist. Surv.* 1923, p. 404.

[2] R. Matheson and C. R. Crosby, *Ann. Ent. Soc. Am.*, 5, 1912, p. 68.

[3] H. B. Hungerford, Life History. *Ent. News*, 28, 1917, p. 267.

that they are used for food in Mexico. It is a neotropical species ranging north into Texas, Arizona, Utah, Nevada, California, and Oregon. De La Torre-Bueno has taken it from saline lakes in several States.[1] *N. mexicana* Amyot and Serville is 11–14 mm. long, dark with luteous brown markings, and with red, orange, and yellow hemelytra with black markings. It ranges from Mexico into Arizona, Colorado, and California. There are two varieties. *N. shooteri* Uhler is a very interesting black and whitish species 8–13 mm. long which ranges from Central America north through Mexico into Central California. *Buenoa carinata* (Champion) is a small pale yellow and black species 9 mm. long, occurring in New Mexico and common in California.

NAUCORIDÆ. Water Creepers.

The western water creeper, *Ambrysus signoreti* Stål, is 8 mm. long, broadly oval, flat and pale yellowish brown with darker markings. It ordinarily lives in quiet pools along streams and particularly grassy places. It is at times troublesome in the swimming pools of Southern California. It is a Mexican species ranging also into Arizona, New Mexico, and Colorado. There are a number of other species in the Southwestern States.

NEPIDÆ. Water Scorpions.

These are water bugs with broad, flat bodies (*Nepa*), or with round linear bodies (*Ranatra*), raptorial front legs with scissors-like claws for holding prey, two tail-like respiratory organs, three pairs of so-called false spiracles on the undersides of the abdomen, very short 3-jointed proboscis, and conspicuous compound eyes. They are predaceous and voracious insects greatly feared by country lads and are capable of administering a severe bite if not handled cautiously. They live on brush, weeds, in or at the bottoms of pools of shallow water, and lie in wait for their prey, or they may occasionally be found swimming laboriously on the surface. *Ranatra* stridulates under water by means of rasping areas on the coxa and in the coxal cavities of the front legs. The western species are all long and slender in form.

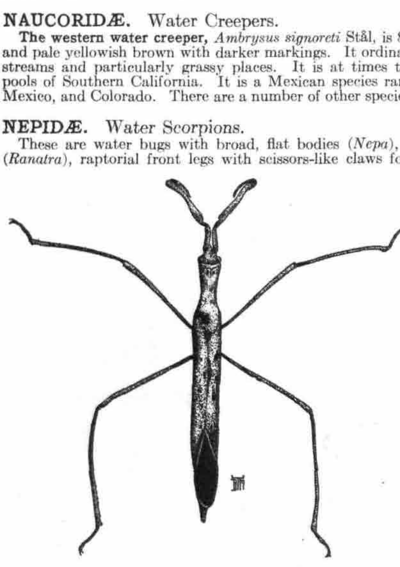

FIG. 247.—The western water scorpion, *Ranatra brevicollis* Montandon.

Ranatra americana Montandon (*R. quadridentata* Stål) is uniformly dark brown. The body averages 25 mm. in length, and the tails 25 mm. long. The anterior femora are bidentate. It is an eastern species ranging west into Colorado, Arizona, and Lower California. *R. brevicollis* Montandon (Fig. 247) is brown throughout and is about the same size as the preceding. It occurs throughout California.

BELOSTOMATIDÆ.[2] Giant Water Bugs, Toe Biters, Electric Light Bugs.

These very large aquatic bugs are among our very largest insects. They have broad, flat, elongated bodies with leathery exoskeleton and hemelytra,

[1] *Ent. News*, 23, 1912, p. 20.
[2] Also spelled *Belostomidæ*.

well developed wings in the adults of the large species at least, short, 5-jointed rostrum, large compound eyes, raptorial front legs with two claws in the nymphs and one in the adults, other legs developed for swimming, and two short posterior breathing organs. They live at the bottom of shallow water and are voracious feeders on tadpoles, snails, young fish, water insects, and so on, and are destructive to fish in open pools which they enter by flight. The name "toe-biter" comes from the vise-like grip they give if stepped on with bare feet. They also inflict a severe bite and inject poison in the wounds of their victims to assist in subduing and killing them.

The giant water bug or electric light bug, *Lethocerus americanus* (Leidy) (*Belostoma*) (Fig. 248), is a giant brown bug varying from 45 to 60 mm. in

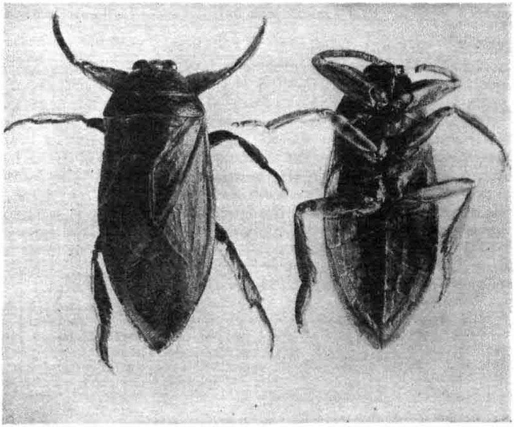

FIG. 248.—The giant water bug or electric light bug, *Lethocerus americanus* (Leidy).

length and from 20 to 25 mm. in width. It is attracted to the electric lights on summer nights and is often stranded in the street gutters in the mornings. It is generally distributed throughout the United States and Canada and is the commonest species in California; it is reported also from Nevada, Utah, and Colorado. *L. annulipes* (H. S.) and *L. angustipes* (Mayr) range from Mexico into California and the former also into Colorado. *Belostoma fusciventris* (Dufour) ranges in New Mexico, Arizona, and California. *B. bosci* Lep. and Serv. occurs in Arizona and California. *B. bakeri* Montandon and *B. apache* Kirkaldy var. *cubænsis* (Mayr) occur in California. The members of this genus are smaller than the preceding and the females glue the eggs to the backs of the males.

The ferocious water bugs or toe-biters belonging to the genus *Abedus* (*Deinostoma, Pedinocoris*) are smaller, more oval and flatter brown bugs about half as large as the giant water bug. The backs of the males are also often fairly covered with the pale brown elongated eggs attached thereto by cement and which are carried until they hatch. The feeding habits are much like those of former species. *Abedus macronyx* Mayr is 30 x 18 mm. and ranges from Mexico into Arizona, California, Oregon, and Washington. *A. brevipes* Stål, *A. dilatatus* (Say), *A. indentatus* (Hāldeman) are Mexican forms ranging into Arizona and California.

GELASTOCORIDÆ.[1] Toad Bugs.

These are small oval bugs with rough, mottled aspect, large, widely separated eyes and short legs. They greatly resemble small toads in appearance and movement, even to the familar hopping and semi-erect carriage, and are predaceous in habits, frequenting the edges of streams and ponds. Their coloring is variable and often matches to a remarkable degree the sand or pebbles on which they occur. *Gelastocoris variegatus* (Guérin) (*Galgulus*) is 7 mm. long and of various shades of gray. It is the commonest species in California and also occurs in Nevada, New Mexico, Texas, and Mexico. The eastern *G. oculatus* (Fabr.) ranges west into Colorado, California, and Arizona.

CORIXIDÆ. Water Boatmen.

These insects somewhat resemble the back swimmers but are easily distinguished by the upright method of swimming and by the characters given in the key. They frequent all forms of fresh and even brackish water, living on small aquatic animals. They are strong fliers and often swarm in countless numbers about the electric lights on warm summer evenings, The males are characterized by the asymmetrical structure of the abdominal segments, a currycomb-like organ known as the "strigil," the front tarsi or palæ provided with one or two rows of chitinous "pegs" or "teeth," and the front usually convex, while in the females the abdomen is symmetrical, the front is concave, and the other organs are missing.[2] The eggs are attached to water plants and other objects, there being two or more broods annually. There are a large number of species, occurring in various parts of the country and from Alaska to Lower California in the west.

[1] *Nerthridæ* of some modern writers and *Galgulidæ* of older workers.
[2] J. F. Abbott, Bul. 34, *Conn. Geol. and Nat. Hist. Surv.* 1923, p. 386.

CHAPTER XXIII

COLEOPTERA (Order)[1]

(*Coleos*, sheath; *pteron*, wing)

Beetles and Weevils

The members of this very large order are characterized by the horny exoskeleton; corneous or leathery front wings or elytra, and membranous hind wings; strong biting and chewing mouth parts; complete metamorphosis. This is the largest order of insects and its members are among the most specialized and are adapted for living under the greatest varieties of conditions, being aquatic and terrestrial, aërial and subterranean, carnivorous and herbivorous, beneficial and destructive. The larvæ or grubs are almost too variable for brief characterization. Some are flat and thysanuriform, while perhaps the great majority are cylindrical and wormlike with or without three pairs of legs. Because of the size of the order only the more important families and the common species can be included.

KEY TO SUBORDERS

Outer lobe or galea of maxillæ palpiform; first visible ventral abdominal segment divided by the hind coxal cavities; hind wings with one or two cross veins near the middle; pleural sutures of prothorax present; antennæ filiform or nearly so; tarsi 5-jointed; larvæ thysanuriform, the tarsi with one or two claws. Largely predaceous or carnivorous.. **Adephaga** p. 370

[1] J. L. Leconte and G. H. Horn, "Classification of the *Coleoptera* of N. A." Bul. 507, *Smithsonian Miscl. Coll.*, 1883.
Samuel Henshaw, "List of the *Coleoptera* of N. A." *Am. Ent. Soc.*, 1885.
John Hamilton, "Cat. of *Coleoptera* of Alaska." *Trans. Am. Ent. Soc.*, 21, 1894, p. 1.
Geo. C. Champion, *In Biologia Centr. Am.* Vols. 3, 4, 6, 1894–1910, and many other references. (See Leng's *Catalogue*, p. 377.)
H. C. Fall, "List of the *Coleoptera* of Southern California." *Occ. Papers, Cal. Acad. Sci.*, 8, 1901.
H. C. Fall and T. D. A. Cockerell, "*Coleoptera* of New Mexico." *Trans. Am. Ent. Soc.*, 33, 1907, p. 145.
J. H. Keen, "Beetles from Northern British Columbia." *Can. Ent.*, 37, 1905, p. 297.
Thos. L. Casey, *Memoirs on Coleoptera, Lancaster, Pa.*, 1, 1910 to 8, 1918. And very many other papers. (See Leng's Catalogue, p. 375.)
E. A. Schwarz, "*Coleoptera* of Harriman Alaska Expedition." *Proc. Wash. Acad. Sci.*, 2, 1900, p. 523.
W. S. Blatchley, *Coleoptera of Indiana*. Nature Pub. Co., Indianapolis, Ind., 1910.
W. S. Blatchley and C. W. Leng, *Rhynchophora of N. E. America*. Nature Pub. Co., Indianapolis, Ind., 1916.
C. W. Leng, "List of N. A. Families of *Coleoptera*." *Bul. Brooklyn Ent. Soc.*, 11, 1916. p. 1. *Cat. of Coleoptera of America North of Mexico*. John D. Sherman, Jr., 1920. (Contains complete Bibliography.)
F. S. Stickney, "The Head Capsule of *Coleoptera*." *Ill. Biol. Mon.*, 7, No. 1, 1923.
The writer has been very greatly assisted by Edwin C. Van Dyke in working up this order.

Outer lobe or galea of maxillæ not palpiform; first visible ventral abdominal segment not usually interrupted by the hind coxal cavities; hind wings without cross veins; pleural sutures of prothorax absent; antennæ and tarsi variable; larvæ variable, the tarsi and claws fused. Animal and vegetable feeders........... **Polyphaga** p.

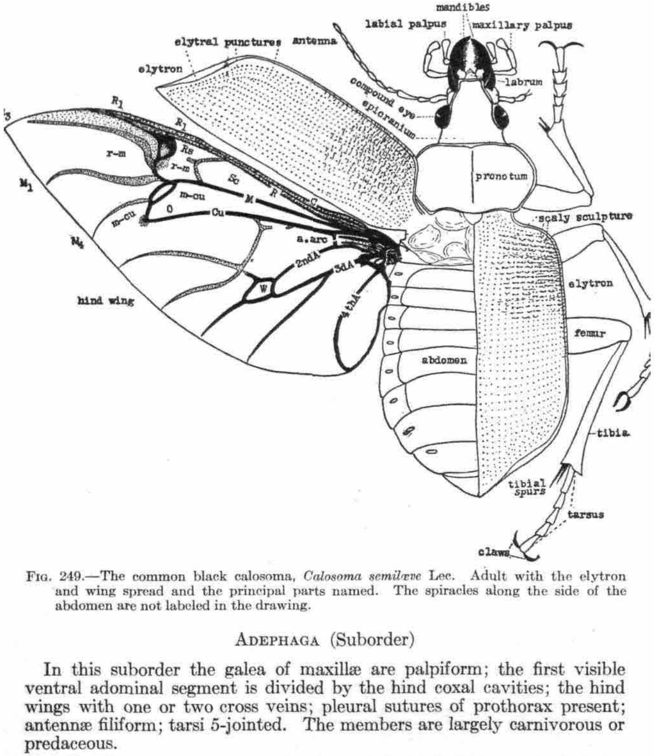

FIG. 249.—The common black calosoma, *Calosoma semilæve* Lec. Adult with the elytron and wing spread and the principal parts named. The spiracles along the side of the abdomen are not labeled in the drawing.

ADEPHAGA (Suborder)

In this suborder the galea of maxillæ are palpiform; the first visible ventral adominal segment is divided by the hind coxal cavities; the hind wings with one or two cross veins; pleural sutures of prothorax present; antennæ filiform; tarsi 5-jointed. The members are largely carnivorous or predaceous.

KEY TO FAMILIES

(Figs. 249, 250)

1. Abdomen with 6, 7 or 8 visible ventral segments, the first three fused but with visible sutures.. 2

Abdomen with 5 visible ventral segments; antennæ 11-jointed, metasternum with a deep antecoxal suture extending almost across, scarcely produced between the *posterior coxæ*. . . . . **Cupesidæ**

2. Metasternum with a well marked transverse suture in front of the hind coxæ. . . . 3
Metasternum without a transverse suture in front of the hind coxæ. 6

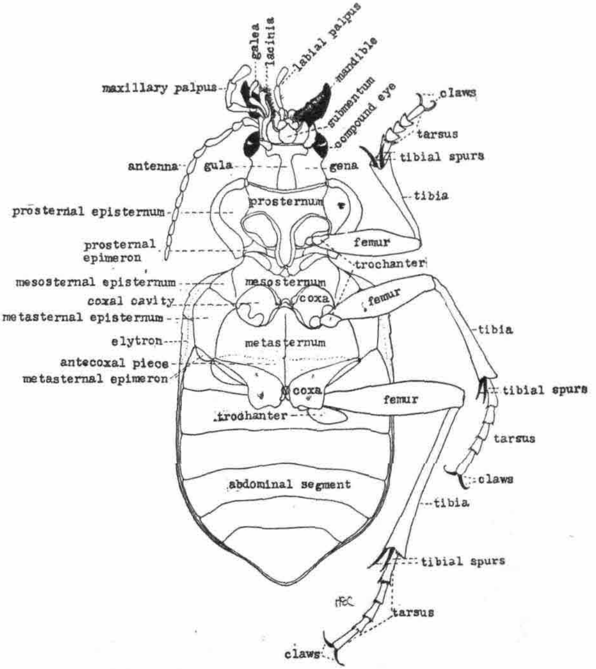

FIG. 250.—The common black calosoma, *Calosoma semilæve* Lec. Ventral aspect of adult to show the principal body parts.

3. *Transverse suture in front of hind coxæ extending across the metasternum which* is continued behind in a triangular process between the hind coxæ. 4
Transverse suture in front of hind coxæ very short, reaching only across the central portion; metasternum not prolonged between the hind coxæ; front coxæ globular: tibiæ and tarsi without swimming hairs; small dull aquatic or semi-aquatic beetles. Rare. . . . . **Amphizoidæ**

4. Hind coxæ normal; antennæ 11-jointed, with at least the 6 apical joints pubescent; terrestrial 5
   Hind coxæ fixed and extended into two broad plates covering the femora and the base of the abdomen; antennæ 10-jointed, without pubescence; hind legs without fringe of long hairs for swimming; aquatic. Small oval usually dark water beetles . . . . **Halipalidæ**

5. Clypeus extending on each side beyond the base of the antennæ; antennæ inserted on the front above the base of the mandibles; inner lobe or lacinia terminating in a movable hook; eyes large; head vertical, wider than thorax. Usually medium sized slender brightly colored or metallic blue and green beetles with yellow marks. They occur along waterways. Very alert and active. (Tiger Beetles.) . . . . **Cicindelidæ**
   Clypeus not extending beyond the base of the antennæ; antennæ arising from the sides of the head between the base of the mandibles and the eyes; inner lobe or lacinia of maxillæ not terminating in a movable hook; eyes normal; head horizontal or slightly inclined, usually narrower than thorax. Small to large usually black, but may be brightly colored reddish, blue and green. Fast running. (Predaceous Ground Beetles.) . . . . **Carabidæ** p. 374

6. Hind coxæ contiguous on their inner margin; metasternum produced between them as a triangular process; legs with fringes of hairs for swimming. Aquatic. 7
   Hind coxæ widely separated; metasternum emarginate before them, very large and almost as long as the abdomen; head with a slender neck; antennæ moniliform; abdomen with 6 visible ventral segments; scutellum wanting; first abdominal segment triangular; front tibiæ terminating in two hooks. Rare brown or black beetles living under bark of trees . . . . **Rhysodidæ**

7. Eyes normal; antennæ slender; abdomen with 6 visible ventral segments; hind legs with long fringes of hairs; males with the 3 basal joints of front tarsi dilated. Small to large brown or blackish water beetles. (Predaceous Diving Beetles.) . . . . **Dytiscidæ** p. 377
   Eyes divided into two each; antennæ abnormally short; abdomen with 7 visible ventral segments; middle and hind legs forming short, broad paddles. Small shiny black beetles. (Whirligig Beetles.) . . . . **Gyrinidæ**

CICINDELIDÆ.[1] Tiger Beetles.

The tiger beetles are so-called because of their predatory habits and also perhaps because of the suggestive white or yellow stripes and markings on the otherwise metallic elytra. They are exceedingly quick on foot and wing and inhabit the sandy or gravelly shores of streams and lakes or the near vicinity of water. The larvæ are white, yellowish or dusky, cylindrical with hard flat heads and a hump on the fifth abdominal segment to prop them in the small, round tube-like holes in which they live and from which they partially emerge to grab any small living prey which comes within reach. The family is a large one and is considered beneficial.

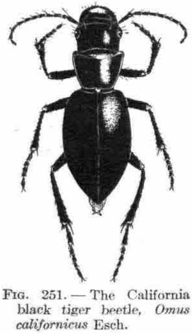

FIG. 251. — The California black tiger beetle, *Omus californicus* Esch.

Members of the genus *Omus* are black, wingless, nocturnal beetles from 12–18 mm. long which are rather common in the west. The larvæ are white or yellow with

[1] F. G. Schaupp, "Rev. of *Cicindelidæ*." *Bul. Brooklyn Ent. Soc.*, 6, 1883–84, pp. 73, 121.
C. W. Leng, Rev. of *Cicindelidæ* of Boreal America." *Trans. Am. Ent. Soc.*, 28, 1902, p. 93.

black pigmentation and live in smooth round holes in hard soils. *Omus dejeani* Reiche is the largest species, from 15–20 mm. long, and has deep irregular pits on the elytra. The larvæ have 4 pairs of eyes and are 25 mm. long and 4 mm. in diameter. This beetle occurs in the foothills and mountains of British Columbia, Washington, and Oregon. *O. edwardsi* Crotch resembles the preceding, but is smoother and 14–18 mm. long. It occurs on the west slopes of the Sierras in California. *O. audouini* Reiche has the apical and discal margins of the prothorax smooth and is 13–18 mm. long. It is common in the foothills and mountains along the Pacific Ocean from British Columbia into California. *O. californicus* Esch. (Fig. 251) has the thorax deeply rugose and is 14–17 mm. long. It is common on the foothills of the San Francisco Bay region and the Coast Range Mountains. *O. lecontei* Horn is shining black, 16–17 mm. long, the elytra attaining the greatest width in front of the middle. It also occurs in the Coast Range Mountains of Central and Southern California. *O. horni* Lec. and a large number of other species inhabit the high west slopes of the Sierra Nevada Mountains of California and Oregon.

FIG. 252.—The Oregon tiger beetle, *Cicindela oregona* Lec.

Members of the genus *Cicindela* are the common, well known forms in which the body is dull or bright iridescent blue, green, bronze or other colors, often with yellow markings on the elytra. There are a great many species. *Cicindela longilabris* Say is a fine bronze, boreal species known in Arctic America and ranging from Alaska south along the Rocky Mountains to New Mexico where it occurs at 7,500 to 8,000 feet altitude. There are many varieties and races occurring throughout the west. The variety *perviridis* Schaupp, is one of the most beautiful, colored bright iridescent green or bluish bronze with bright yellow markings. It occurs in California, Oregon, and Utah. *C. oregona* Lec. (Fig. 252) is a rather dull metallic species with yellow markings, which is perhaps the commonest species in the west. It is known in Alaska, British Columbia, Washington, Idaho, Montana, Utah, Nevada, Oregon, California, Arizona, and New Mexico. *C. latesignata* Lec. and *C. sigmoidea* Lec. occur along the ocean beaches of Southern California. *Tetracha carolina* (Linn.) (Fig. 253) is a very beautiful species being light, old gold-green, the tip of the abdomen, the apices of the elytra, legs, and antennæ luteous, the whole body often iridescent old rose. The thorax is smooth and the elytra coarsely

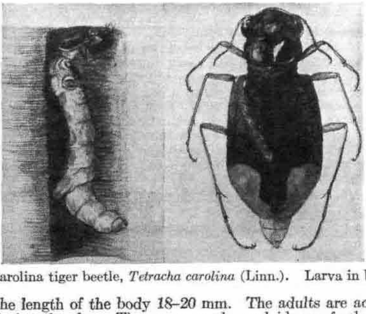

FIG. 253.—The Carolina tiger beetle, *Tetracha carolina* (Linn.). Larva in burrow and adult.

punctured, and the length of the body 18–20 mm. The adults are active at dusk and night and hide during the day. The eggs are always laid near fresh water where the holes of the larvæ, which are 12–18 inches deep, occur. The larvæ are 17 mm. long, the body yellowish, and the head and thorax which are held at right angles to the body are shiny blackish or bronze. This species occurs throughout the Southern

States. In Texas the adults are called "the white-eyed bugs." The form occurring in New Mexico, Arizona, and California is placed as a variety *mexicana* (Gray). *T. virginica* (Linn.) is 20–24 mm. long and a dark gold green species with the last ventral segment brownish yellow. It ranges west into Colorado.

CARABIDÆ.[1] Predaceous or Carnivorous Ground Beetles.

This is a very large family of small to large, usually sombre, rarely metallic and brightly colored, long legged, strong jawed beetles which are nocturnal in habits. They hide during the day under stones or other objects and run swiftly when disturbed. Many secrete an offensive and volatile liquid which is used in defense. The wings are well developed or absent and the basal tarsal joints of the front legs of the males are usually dilated. They are among the commonest insects and are to be found everywhere. The larvæ are fusiform, depressed, tapering anteriorly and posteriorly from the fourth abdominal segment. There are usually 6 ocelli on each side of the head. The antennæ are usually filiform, rarely conical, and 14 jointed. The mouth parts are exserted and free, the mandibles sickle-shaped. Cerci are usually present on the ninth abdominal segment. As in the case of the adults, the mandibles merely crush the prey and do not have furrows or tubes to aid in sucking the juices up by the mouth. They are predaceous on caterpillars, grubs, grasshoppers, snails, such other small animals as they can overtake and subdue, and are nocturnal in habits, a very nice adaptation for the effective destruction of the armyworms and cutworms which also feed at night. The eggs are usually laid in the ground. *Chelænius tricolor* Dej., a widely distributed species, constructs an egg cell of fine clay sand on the stems of slender grasses and sedges along rivers. These mud cells are 2 x 1.25 mm., rounded oblong, smooth, with a distinct fold or lap marking the point of closure at one end.[2] The family as a whole is one of the most beneficial because of the destruction of serious insect pests, snails, and slugs. Only a few occasionally eat berries, the amount consumed being very trival compared with the insect diet of the same species.

The snail eaters belonging to the genus *Scaphinotus* (*Brennus*, *Pemphus*) and *Cychrus*,[3] are large black or reddish brown beetles often with purplish iridescence and characterized superficially by powerful jaws, narrow prothorax, and large abdomen. They feed on snails, slugs, cutworms, and other small ground animals. The larvæ are dark brown or black and heavily chitinized with sharp jaws and well-developed antennæ. *S. angusticollis* (Fischer) is 17–25 mm. long, is reddish brown in the far north and black in its southern reaches. It extends from Siberia and Alaska through British Columbia, Washington, and Oregon into Northern California. *S. marginatus* (Fischer) is 12–19 mm. long, iridescent dark purplish, and extends from Alaska into Oregon. *S. cristatus* (Harris), *S. cordatus* (Lec.), *S. interruptus* (Menet.), *S. striato-*

[1] G. H. Horn, "*Carabidæ* of Boreal America." *Trans. Am. Ent. Soc.*, 9, pp. 91–196, 1881.
G. Dimmock and F. Knab, "Early Stages of *Carabidæ*." Bul. 1, *Springfield Mus. Nat. Hist.* 1904.
R. Hayward, "Species of *Bembidium* of Am." *Trans. Am. Ent. Soc.*, 24, 1897, p. 32. "Species of *Tachys* of Boreal America." *Trans. Am. Ent. Soc.*, 26, 1899, p. 191. "Studies in *Amara*." *Trans. Am. Ent. Soc.*, 34, 1908, p. 13.
A. F. Burgess and C. W. Collins, "The Genus *Calosoma*." Bul. 417, *Prof. Paper*, Bur. Ent. U. S. Dept. Agr. 1917.
[2] J. L. King, *Ann. Ent. Soc. Am.*, 12, 1919, p. 384.
[3] The classification is that of Hans Roeschke in *Annales Musei Nat. Hungarici*, 5, p. 99, 1907.

punctatus (Chaudoir) (Fig. 254, A), and *S. ventricosus* (Dej.) are all black with bluish or purplish sheen but not strongly iridescent. They are all common in Central California, *S. cristatus* (Harris) ranging into Central Oregon and *S. ventricosus* (Dej.) into Southern California. The writer has many times observed different ones of these species feeding on the small gray garden slug, *Agriolimax agrestis* (Linn.), in the San Francisco Bay region.

Cychrus hemphilli Horn is similar to the preceding species in form, being 15–18 mm. long and black in color. It occurs in Wyoming and Utah, and the subspecies *rickseckeri* Lec., is recorded from Montana and Idaho.

The members of the genus *Calosoma* are large beetles with large well developed jaws and prothorax nearly as wide as the abdomen and much wider than the head. The color is black, green or bronze or a combination

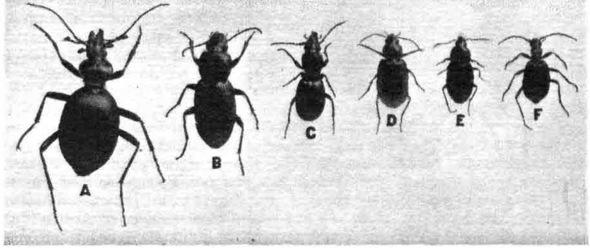

FIG. 254.—Common western carabid beetles. A, *Scaphinotus striatopunctatus* (Chaudoir); B, *Pterostichus californicus* (Dej.); C, *Promecognathus lævissimus* Dej.; D, *Platynus maculicollis* (Dej.); E, *Calathus ruficollis* Dej.; F, *Brachinus tschernikhi* Mann.

of these, often with a bright metallic iridescence. The adults hibernate in the soil. The larvæ are flat, strongly chitinized, black and white, and like their parents are ferocious enemies of caterpillars, slugs, and other small living prey. The majority live on the ground, but some readily ascend trees and feed not only on caterpillars but tear open the cocoons and destroy the chrysalids as well. They are among the most beneficial members of the insect world. **The fiery ground beetle,** *Calosoma calidum* Fabr., is 22 mm. long, and black with six rows of golden spots in the deep punctures of the striated elytra. It is a very striking species occurring in many parts of the United States and ranging west into New Mexico, Montana, and British Columbia. It is especially predaceous on cutworms and armyworms. *Calosoma cancellatum* Esch. is similar, being 19 mm. long with rough elytra and the rows of deep punctures without the golden spots. It is known in Oregon, California, Nevada, and Utah, and is common in the fields and gardens. J. E. Graf[1] reports it as killing the adults of the sugar beet wireworm, *Pheletes californicus* (Mann.), in California. *Calosoma haydeni* Horn is 22 mm. long, shining black throughout with elytral striæ and punctures. It occurs in Colorado. *Calosoma obsoletum* Say is 20 mm. long, black, the elytra with scaly sculpture. It ranges west

[1] Bul. 123, Bureau U. S. Dept. Agr. 1914, p. 47.

into New Mexico and Colorado and is reported by C. R. Jones [1] as feeding on young grasshoppers in Colorado. *Calosoma peregrinator* Guerin is 30 mm. long, black, the elytra faintly striate. It occurs in New Mexico, Arizona, and Southern California, and feeds on cutworms and climbs trees for other caterpillars. *Calosoma scrutator* Fabr. is 30–34 mm. long, steel blue with green striate elytra margined with gold. The head and the entire margin of the prothorax are also gilded. The larvæ are dirty yellow with the head and scutes brown. The adults live on the ground or freely climb trees in search of caterpillars. This species is more or less common throughout the country and is reported in Colorado, New Mexico, and California in the west. *Calosoma sycophanta* Linn.[2] is similar in size and color to the preceding but lacks the gold margins. It was introduced into the United States from Europe to feed on the gypsy and brown-tail moths. Two colonies of about 1,000 individuals were brought into California by the State Insectary in the spring of 1918, to prey upon the tree-infesting caterpillars. **The common black calosoma,** *Calosoma semilæve* Lec. (Figs. 249, 250, 255), is 25 mm. long, black, almost smooth, the striæ and punctures being very minute. The larvæ are shining black above with white markings on the sides and venter. When mature they are 25 mm. long. This species is common throughout California and feeds on cutworms, armyworms, and other caterpillars, and on wireworms. *Callisthenes zimmermanni* (Lec.) (*Calosoma*) is 20 mm. long, jet black, faintly sculptured or smooth, wingless, occurring in Washington, Oregon, and Northern California. It is reported by A. L. Melander and M. A. Yothers as attacking young coulee crickets in Washington.

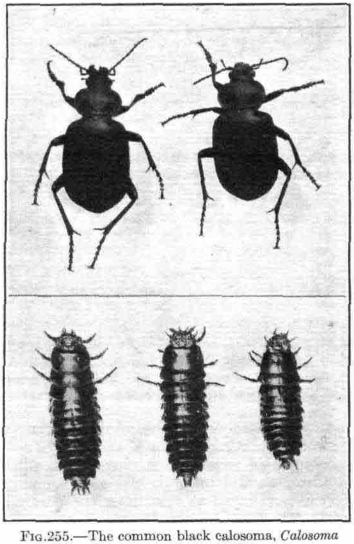

FIG. 255.—The common black calosoma, *Calosoma semilæve* Lec. Adults and larvæ.

The genus *Pterostichus* is a very large and common one in the west. The beetles are represented by the accompanying illustration. *P. californicus* (Dej.) (Fig. 254, B)

[1] Bul. 233, Colo. Agr. Exp. Sta. 1917.

[2] A. F. Burgess, Bul. 101, Bur. Ent. U. S. Dept. Agr. 1911. Bul. 251, *Prof. Paper*, Bur. Ent. U. S. Dept. Agr. 1915.

with its many forms is certainly the commonest species in California. It is especially common under stones and has been observed feeding on the larvæ of the codling moth on the ground.

The rufous carabid, *Calathus ruficollis* Dej. (Fig. 254, E), is well described as to color by the common name. The prothorax is brighter reddish than the finely striated elytra. The length is 8 mm. It is very common under stones, and also attacks the larvæ of the codling moth and other small caterpillars in California. **The tule beetle,** *Platynus maculicollis* (Dej.) (Fig. 254, D), is 10 mm. long, pale brown with a small darker blotch in the middle of the prothorax and a large darker blotch occupying much of the dorsum of the elytra. It breeds in the marsh lands along the rivers, and often appears in large swarms at dusk following rains, in the fall of the year. It freely enters houses and is very annoying because of the very offensive odor. It has been known as a nuisance in the Sacramento and San Joaquin Valleys in California since 1882. In reality the beetle means no harm and except for entering houses is beneficial. It probably occurs in many parts of the west. Other common names applied to it are **overflow bug, tule bug, stink bug,** and **grease bug.** **The malodorous carabid,** *Nomius pygmæus* (Dej.), also has a very offensive smell, but never enters houses. It occurs in California and Oregon. **The bombardier beetle,** *Brachinus tschernikhi* Mann. (Fig. 254, F) (*Brachynus*), is interesting because of the very distinct explosions it produces in the expulsion of the defensive volatile protective fluid from the tip of the abdomen. The reports are accompanied by a vapor which is very pungent. The beetles are small, only 10 mm. long, amber with very dark blue somewhat metallic and striated elytra. They occur under rocks, logs, or masses of dead leaves, are exceedingly agile and often escape after the bombardment without being seen at all. It occurs in California and Arizona.

The murky ground beetle, *Harpalus caliginosus* (Fabr.), is the most noted member of another very large genus of carabid beetles. It is shining dull or reddish black with deeply striated elytra. The thorax is the same width as the elytra and the length 23 mm. The larvæ are black with a red head, and taper anteriorly with two long tail-like cerci. This beetle is well distributed throughout the United States and occurs in the west in New Mexico, Arizona, and California. It normally feeds upon other insects, including the Colorado potato beetle, but occasionally does considerable injury by eating ripening strawberries.

DYTISCIDÆ.[1] Predaceous Water Beetles.

The most conspicuous member of this large family in California, at least, is *Dytiscus marginicollis* Lec. It is 30 mm. long, smooth, dull green, with the entire margin of the prothorax and the sides of the elytra yellow. The adults fly readily at night and are, as well as the large elongated larvæ, predaceous on all small aquatic insects. In fact the latter are so ferocious as to be called water tigers and are sometimes very destructive to young fish.

Polyphaga (Suborder)

In this suborder the galea of the maxillæ are not palpiform; the first visible ventral abdominal segment is not usually interrupted by the hind coxal cavities; the hind wings lack cross veins; the prothoracic pleural sutures are absent; the antennæ and tarsi are variable. The members are largely vegetable feeders, but many are carnivorous, and some feed on carrion.

[1] G. R. Crotch, "Rev. of the *Dytiscidæ*." *Trans. Am. Ent. Soc.*, 4, pp. 383–424, 1873.
H. C. Fall, "Review of the N. A. Species of *Agabus*." *J. D. Sherman, Jr.* N. Y., 1922. "Rev. of N. A. species of *Hydroporus*." *J. D. Sherman Jr.*, N. Y., 1923.

KEY TO SERIES OF POLYPHAGA [1]

1. Palpi flexible; gular sutures double 2
   Palpi rigid or concealed; gular sutures single 9

2. *Hind wings with simple, straight veins; abdomen with at least three chitinous segments dorsally and more or less exposed by the short elytra; antennæ variable, but never lamellate; tarsi variable; larvæ thysanuriform with legs. Largely carrion beetles.* (Series II.) .... **Staphyliniformia** p. 379
   Hind wings with recurrent veins or in part connected by loops; abdomen with not more than two chitinous segments dorsally, usually completely covered by the elytra; antennæ and tarsi variable; larvæ variable 3

3. Antennæ never lamellate; number of tarsal joints variable 4
   Antennæ lamellate; tarsi 5-jointed 7

4. *Palpi never longer than antennæ, tarsi variable* 5
   Palpi often longer than antennæ, tarsi usually 5-jointed 6

5. Antennæ variable, usually filiform, serrate or modifications of same, never lamellate or clavate; body often elongate, not strongly chitinized; tarsi 5-jointed or heteromerous; larvæ often greatly differentiated and most often with short legs or legless. Beetles of variable habits. (Series III.) .... **Polyformia** p. 384
   Antennæ variable, usually clavate or thickened externally; tarsi variable, heteromerous, or 4- or 3-jointed; abdomen with 5 visible ventral segments; body strongly chitinized; larvæ variable with legs. Predaceous and plant-eating beetles. (Series IV.) .... **Clavicornia** p. 406
   Antennæ variable, usually serrate or with outer joints wider, sometimes pectinate or flabellate; tarsi 4-jointed 8

6. Antennæ clavate, body strongly chitinized; larvæ thysanuriform with legs. Water and land beetles. (Series I.) .... **Palpicornia**

7. Body usually strongly chitinized; pleuræ of second and third abdominal segments separated by suture between the sternites; larvæ eruciform with legs. Largely plant feeders, some few predaceous. (Series V.) .... **Lamellicornia** p. 439

8. Palpi with last joint triangular or small in some families; tarsi 5-jointed, the fourth joint minute and fused in a notch at the base of the fifth; laroæ usually eruciform, sometimes legless. Destructive wood-boring and plant-eating beetles. (Series VI.) .... **Phytophaga** p.448

9. Antennæ variable and of many types; head frequently prolonged into a beak; prosternal sutures wanting; abdomen usually completely covered by elytra; tarsi 4-jointed excepting in certain bark beetles; larvæ eruciform and usually legless. (Series VII.) .... **Rhynchophora** p. 488

PALPICORNIA OR HYDROPHYILOIDEA (Series I)

HYDROPHILIDÆ. Water Scavenger Beetles.

The giant water scavenger beetle, *Hydrous triangularis* (Say) [2] (*Hydrophilus*) (Fig. 256), is the best known member of this family. It is a large shining black beetle, 34–37 mm. long, with a prominent keel or metasternal

[1] Arrangement modified from Charles W. Leng, *Catalogue of Coleoptera of N. A.* 1920, p. 15.
The *Staphyliniformia, Hydrophiloidea, Palpicornia, Polyformia,* and *Clavicornia* form a more or less common group and are not so well differentiated as the other series.

[2] R. Matheson, Life History Notes. *Can. Ent.*, 46, 1914, p. 337.

spine on the middle of the venter. The small cylindrical-oval yellow eggs are 4 x 1 mm. and are enclosed in a silken warp. They are laid in a smooth brownish egg case or nidus 22 mm. wide, 24 mm. long, 15 mm. deep, which has a horn-like mast and which floats on the surface of the water or may be attached to a floating leaf, weed, or other objects. The young and adults are carnivorous, devouring all procurable dead and living aquatic animals, and are sometimes troublesome in fish hatcheries. The species is widely distributed throughout North America and occurs in many of the Western States. *Tropisternus californicus* (Lec.) is a small black shining water beetle, reported to have bitten bathers in swimming pools of Southern California.

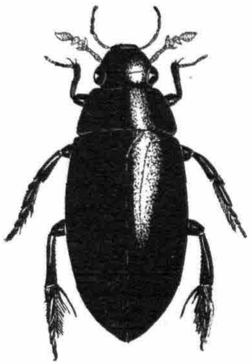

FIG. 256.— The giant water scavenger beetle, *Hydrous triangularis* (Say).

STAPHYLINIFORMIA OR STAPHYLINOIDEA (Series II)

Hind wings without cross veins or loop; antennæ simple; tarsi 3- to 5-jointed

KEY TO FAMILIES

1. Elytra short, leaving greater part of the dorsum of abdomen exposed; wings present, and when not in use folded beneath the short elytra; dorsum of abdominal segments entirely strongly chitinous or horny 2
   Elytra usually long, covering the greater part of the abdomen, or if short, the wings are wanting or are not folded under elytra when not in use; dorsum of abdominal segments partly membranous 3

2. Abdomen flexible with 7 or 8 segments visible ventrally; tarsi 3–5 jointed; body usually slender and often curved over the back. Small to large scavengers. (Rove Beetles.) .... **Staphylinidæ** p. 383
   Abdomen rigid with only 5 segments visible ventrally; maxillary palpi large; tarsi 3-jointed; body robust. Very small usually brown beetles living in ants' nests. (Ant-Loving Beetles) .... **Pselaphidæ**

3. Hind tarsi 5-jointed 4
   All tarsi 3-jointed 12
   All tarsi 4-jointed 13

4. Antennæ elbowed and with a short compact club; elytra truncate behind exposing last two abdominal segments; tibiæ usually all dilated and front pair toothed; hind coxæ widely separated. Small robust usually dull or shining black or red and black. Live in carrion and dung. (Hister Beetles.) **Histeridæ** p. 384
   Antennæ rarely elbowed and not clavate 5

5. Abdomen with 5 ventral segments, the fifth segment conically produced and as long as the three preceding ones; elytra not completely covering the abdomen; *femur joined to side of trochanter; coxal cavities widely open behind; front* coxæ large, conical and contiguous; hind coxæ oval or transverse and widely separated. Very small oval shining species living in fungi, rotten wood and other decaying vegetable matter. (Shining Fungus Beetles.). **Scaphidiidæ** (Part)
   Abdomen with 6 or more ventral segments 6

6. Front coxæ flat; elytra not longer than the prothorax and exposing 5 dorsal abdominal segments; wingless; blind. Small beetles living on beavers. (Beaver Beetles.) .... **Platypsyllidæ**
Front coxæ globular or conical 7

7. Front coxæ globular; mentum large, the bases of the palpi distant; eyes rudimentary or wanting; antennæ long, 11-jointed. Minute beetles living in nests of rodents and on beavers, rare. (Rodent Beetles) .... **Leptinidæ**
Front coxæ conical 8

8. Hind coxæ widely separated 9
Hind coxæ close together 11

9. Eyes finely granulated or wanting; antennæ clavate or filiform; tibial spurs large; apex of abdomen often exposed. Small to large flat or robust sombre or colored species feeding on carrion or decaying organic material. (Burying or Carrion Beetles.) .... **Silphidæ** (Part)
Eyes well developed and coarsely granulated 10

10. Elytra not entirely covering the abdomen; antennæ long, slender, sometimes filiform 10- to 11-jointed; abdomen thick conical, pointed, the last ventral segment elongate; tarsi long and slender .... **Scaphidiidæ** (Part)
Elytra entirely covering the abdomen; antennæ extending apically. Minute shining or dull brown or black somewhat hairy species occurring under bark, stones and wet vegetable matter. (Ant-like Stone Beetles.) .... **Scydmænidæ**

11. Antennæ clavate; hind tarsi not widened .... **Silphidæ** (Part)

12. Wings fringed with long hairs; abdomen with only 3 visible ventral segments; head and eyes large; antennæ short, 11-jointed, clubbed. Rare, minute hemispherical shining species occurring under stones or in damp places. (Hemispherical Beetles) .... **Sphæriidæ**

13. Abdominal sternites distinct, not fused; wings fringed with hairs; hind coxæ close together and with plates wholly or partially covering femora... **Silphidæ** (Part)

PLATYPSYLLIDÆ. Beaver Beetles.

The beaver beetle, *Platypsylla castoris* Reitsema, is the only member of this family. The adults are small, brown, flat, wingless and blind beetles 2.5 mm. long. The beetle in all its stages lives on the beaver. The minute eggs are attached to the skin among the dense hairs. The larvæ are 1.6 mm. long, whitish, elongate-oval, and narrow at both ends. This species ranges in Europe and America, being reported in Alaska and California, and probably occurs wherever the beaver lives.

LEPTINIDÆ. Rodent Beetles.

The rodent beetle, *Leptinillus aplodontiæ* Ferris, is a small reddish brown beetle 3 mm. long. It occurs on the sewellel, a rodent in the Lake Tahoe region of California.

SILPHIDÆ. Burying or Carrion Beetles.

Members of the genus *Necrophorus* are large elongate somewhat robust beetles with truncate elytra exposing the tip of the abdomen. They are the typical burying beetles and are often called sexton beetles on this account. **The yellow-bellied burying beetle,** *Necrophorus guttula* Mots., is a shiny black species 12–20 mm. long, the venter of the thorax clothed with fine yellowish hair. It ranges from Alaska to California, Arizona, and New Mexico. The variety *hecate* Bland, occurs in New Mexico and California. **The red and black burying beetle,** *N. marginatus* Fabr., is 20–27 mm. long, shining black, with the antennal club, epipleural fold, and two wide bands on the elytra orange-

yellow or red. The venter of the mesothorax is clothed with yellow hair. It occurs in many parts of the United States and Canada, and in the west is particularly a Rocky Mountain species ranging in Montana, Wyoming, Colorado, New Mexico, and also in Arizona and California. **The black burying beetle,** *N. pustulatus* Herschel (Fig. 257), is 17 mm. long, shining black, with the antennal club, except the first joint, and two spots on each elytron, orange-red. It is a widely distributed species with many varieties. The variety *melsheimeri* Kirby and its races have the red spots on the elytra and in addition the epipleural fold is also red. They occur in Alaska, British Columbia, Washington, Oregon, California, Arizona, New Mexico, and Colorado. The variety *nigritus* Mann. (Fig. 257) is entirely black excepting the red-tipped antennal club, and is common in California, Arizona, New Mexico, and Texas.

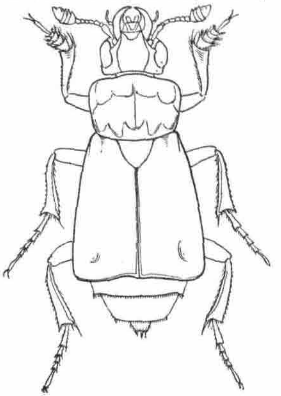

FIG. 257.—The black carrion beetle, *Necrophorus pustulatus* Herschel var. *nigritus* Mann.

Members of the genus *Silpha* are medium or large flattened beetles, somewhat oval with a wide thin margin to the thorax and abdomen. The tip of the abdomen is often exposed. The larvæ are flattened, wider near the anterior end, tapering posteriorly, and composed of armor-like segments usually black in color. The larvæ and adults feed on carrion or on decomposing vegetable matter, and a number are destructive to garden vegetables. These injurious forms are controlled with poison bran mash. **The spinach carrion beetle,** *Silpha bituberosa* Lec.,[1] is 12 mm. long, black with three longitudinal ridges on each elytron, the posterior tip of each marginal ridge ending in a small tubercle. The members hibernate and spend much of their time in the soil, appearing in March. The ellipsoidal, cream-white eggs are smooth, 1.7 to 2.4 m. in diameter, and are laid preferably in moist soil, as deep as 2 inches, during April. The larvæ are black with white connecting membrane and when full grown are 11 to 15 mm. long. They live in the soil and usually feed at night, eating the edges of the leaves, and when disturbed drop to the ground. They pupate one or two inches in the soil. The larvæ and adults are often numerous and destructive to beets, squash, spinach, pumpkin, and other vegetables, alfalfa, wheat, lambsquarters, nightshade, monolepis, and other cultivated and native plants. Beets and spinach are most seriously injured in May when the plants are young. It is typically a plains and mountain species occurring in Montana, Wyoming, Idaho, Washington, British Columbia, Alberta, Kansas, and Nebraska. *Silpha lapponica* Hbst. is 12 mm. long, dull black, with the head and thorax clothed with dense fine yellow hair. It is chiefly a carrion feeder and is a palæarctic species ranging from Northern Europe, Siberia, and Alaska south along the Pacific Ocean into British Columbia, Washington, Oregon,

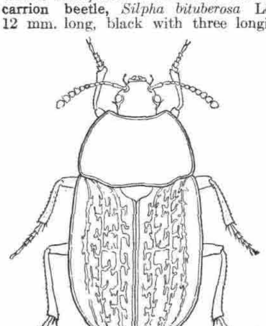

FIG. 258.—The garden carrion beetle, *Silpha ramosa* Say.

[1] R. A. Cooley, *Jour. Econ. Ent.*, 10, 1917, p. 94.

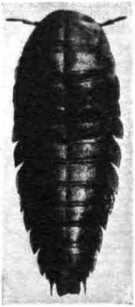

FIG. 259.—The larva of the garden carrion beetle, *Silpha ramosa* Say.

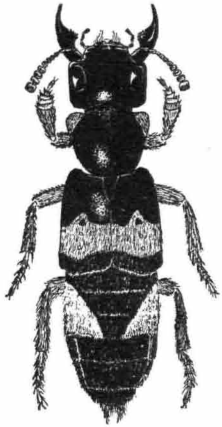

FIG. 260.—The hairy rove beetle, *Creophilus maxillosus* (Linn.) var. *villosus* (Grav.).

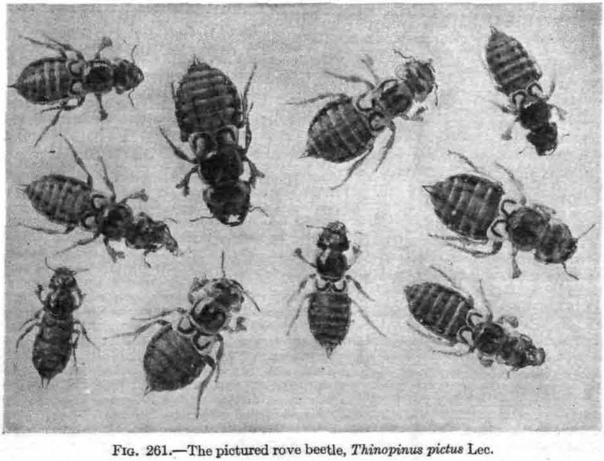

FIG. 261.—The pictured rove beetle, *Thinopinus pictus* Lec.

Idaho, Nevada, California, Utah, Colorado, Arizona, New Mexico, and Mexico. **The beet carrion beetle,** *Silpha opaca* Linn., is 12 mm. long and black. The larvæ are shining black. This species also feeds on vegetables, chiefly the leaves and roots of young beets. It has a range similar to the preceding, from Alaska to California. **The garden carrion beetle,** *Silpha ramosa* Say (Figs. 258, 259), is 12 to 18 mm. long, black with a velvety sheen, and the larvæ are shiny black. This species feeds chiefly upon decomposed vegetable matter but also attacks garden and field crops, grasses, and weeds. It often occurs on lawns. It ranges throughout the whole western area and is known in Montana, Colorado, British Columbia, Washington, Oregon, California, Arizona, and New Mexico.

STAPHYLINIDÆ. Rove Beetles.

The hairy rove beetle, *Creophilus maxillosus* (Linn.) var. *villosus* (Grav.) (Fig. 260), occurs on dead animals and was first thought to be a carrion feeder, but it is now believed that the larvæ and adults of this beetle feed upon the maggots of carrion flies.[1] It is a large robust, shining black beetle, 12 to 21 mm. long, the second, third, and sometimes the fourth abdominal segments densely clothed with yellowish hairs and a similar yellow band across the short elytra. The mandibles are very well developed. It is a widely distributed species throughout Europe and North America. The above variety occurs throughout the west in British Columbia, Washington, Oregon, California, Arizona, and probably most of the other States. The variety *arcticus* Er. occurs in Siberia and Alaska.

The pictured rove beetle, *Thinopinus pictus* Leconte (Fig. 261), is a remarkably interesting wingless beetle, being 15–18 mm. long, yellow or dull amber with black curves, circles, and spots on the dorsum. The jaws are toothed and well developed. The larvæ appear much like the adults but have simple jaws and the second and third thoracic joints are mostly black. This beetle is abundant on the sandy ocean beaches at dusk just above the water line, and is a ravenous feeder on sand fleas and cannibalistic on its own young. It ranges along the Pacific Coast from Lower California as far north as Central California. On the white sands near Monterey, E. C. Van Dyke reports a very pale form, while the darker form *variegatus* (Mots.) ranges from Central California north to Southern Alaska. Another wingless species, *Hadrotes crassus* (Mann.), is a brownish or black beetle also living on the ocean beach from Lower California northward into Alaska and the Aleutian Islands.

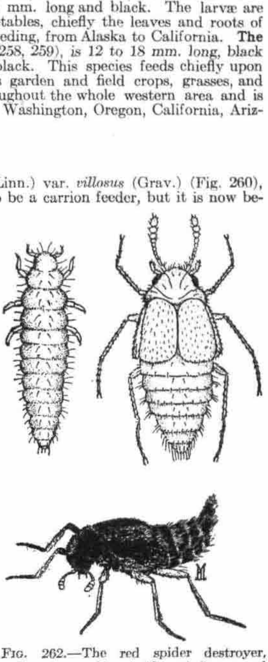

FIG. 262.—The red spider destroyer, *Somatium oviformis* (Casey). Larva and adults. (After Quayle.)

The red spider destroyer, *Somatium oviformis* (Casey) (*Oligota*)[2] (Fig. 262), is a minute slender, shining black beetle, 1 mm. long, which in life constantly curves the abdomen up from under the short elytra. The eggs are oval, orange, and 0.36 mm. long. They are laid singly on the surface of the leaves. The larvæ are yellow and 2.5 mm. long. The adults are often very numerous on the leaves of deciduous fruit and citrus trees and on other plants infested with the common red spider, the two-spotted mite, the European red mite, and other destructive mites in Oregon and in California. The species is especially abundant in the fall of the year from September to November.

[1] W. T. Davis, *Jour. N. Y. Ent. Soc.*, 23, 1915, p. 150.
[2] H. J. Quayle, Bul. 234, Cal. Agr. Exp. Sta. 1912, p. 509.

HISTERIDÆ. Hister Beetles.

Hololepta yucateca (Marseul),[1] is 8–10 mm. long, black and rugose, occurring in decaying cacti and fruits of wild gourd in New Mexico, Arizona, and Southern California. *H. pervalida* Blaisdell occurs in yucca and cacti in Southern California. *Hetærius californicus* Horn,[2] *H. hirsutus* Martin and *H. tristriatus* Horn occur in ants' nests in California. *H. exiguus* Mann infests ants' nests in Washington, Idaho, California, and New Mexico. *Terapus infernalis* (Fall) (*Melanetærius*) occurs in the nests of *Pheidole hyatti* Emery in Southern California and ranges into Arizona.

POLYFORMIA (Series III)

KEY TO FAMILIES

1. Abdomen with 7 or 8 visible ventral abdominal segments.................... 2
   Abdomen with 6 visible ventral segments.................................. 4

2. Middle coxæ distinct; epipleura wanting; elytra usually with reticulated surface; no phosphorescent organs. Largely tropical beetles. (The Net-winged Beetles.)..**Lycidæ** p. 385
   Middle coxæ in contact; epipleura distinct; elytra not reticulate.............. 3

3. Episterna of metathorax sinuate on inner side; head nearly or quite covered by thorax; epipleura usually wide at base of elytra; phosphorescent organs usually present. (Fire Flies).................................**Lampyridæ** p. 386
   Episterna of metathorax not sinuate on inner side; head fully exposed; epipleura narrow at base; anterior coxæ with distinct trochantins; elytra soft; no phosphorescent organs. Medium-sized predaceous beetles. (The Leather-winged Beetles.)..................................(*Telephoridæ*) **Cantharidæ** p. 387

4. Front trochantins present; claws often furnished with a membranous appendage beneath; antennæ filiform or serrate; elytra soft and covering the entire abdomen or leaving the tip exposed. (Soft-winged Flower Beetles.)....... (*Malachiidæ*) **Melyridæ** p. 388
   Front trochantins absent.. 5

5. All tarsi 5-jointed; antennæ serrate, 11-jointed, inserted at sides of head; head deflexed, narrow behind; eyes large. Small narrow wood-boring beetles. (Ship-Timber Beetles)..................................**Lymexylonidæ**
   Front and middle tarsi 5-jointed, hind tarsi 4-jointed......................... 6

6. Sides of prothorax with sharp lateral margins, the base as wide as the elytra; antennæ filiform, 11-jointed; head joined vertically against the thorax; hind coxæ flat; elytra soft; tip of abdomen prolonged into a point. (Tumbling Flower Beetles.)..**Mordellidæ**
   Sides of prothorax rounded and without sharp lateral margins................ 7

7. Hind coxæ normal; tarsal claws simple; antennæ filiform; 11-jointed, inserted before the eyes at the sides of the front; middle coxæ with trochantins. Medium to small ant-like beetles. (Ant-like Flower Beetles.)....**Anthicidæ** p. 391
   Hind coxæ large and prominent; tarsal claws cleft or toothed, head deflexed, front vertical; antennæ 11-jointed, inserted at the sides in front of the eyes; elytra soft and entirely or only partially covering abdomen. Medium to large soft-bodied beetles. (Blister Beetles.)....................**Meloidæ** p. 389

8. Front coxæ transverse, more or less cylindrical............................ 9
   Front coxæ globular or conical... 10

[1] F. G. Carnochan, *Ann. Ent. Soc. Am.*, 10, 1917, p. 386.
[2] W. M. Mann, *Psyche*, 18, 1911, p. 28.

9. Legs stout, retractile; front coxæ open behind; hind coxæ extending to the margin of the body; tibiæ dilated usually with a groove near the apical end for the reception of the tarsi; tibial spurs distinct; last tarsal joint small and quadrate. Small to medium convex beetles. (Pill Beetles.)..... **Byrrhidæ** p. 406
   Legs normal, tibiæ slender, spurs reduced or absent; front trochantins present; antennæ serrate, 11-jointed, inserted below a slight ridge in front of the eyes; claws simple or pectinate. Small to medium terrestrial and aquatic beetles. (Soft-Bodied Plant Beetles.)................................ **Dascillidæ** p. 404

10. Prosternum prolonged backwards into the metasternum...................... 11
   Prosternum not prolonged backwards into the metasternum.................. 14

11. First two abdominal sternites fused or immovable; tarsi with membranous lobes beneath; thorax and abdomen firmly united; antennæ serrate, 11-jointed. Small to large often beautiful metallic and iridescent beetles. (Metallic Wood Boring Beetles.)... **Buprestidæ** p. 395
   All the abdominal segments free and movable............................. 12

12. Prothorax firmly attached to the mesothorax, not movable; front coxal cavities closed behind by mesosternum; prosternal process prolonged but not movable. Minute black or brown beetles. (Pseudo Click Beetles.) **Throscidæ**
   Prothorax loosely joined to the mesothorax and freely movable, the hind angles each prolonged into a tooth; prosternal process loosely received in a socket in the mesosternum; front coxal cavities entirely within the prosternum...... 13

13. Prosternum lobed in front; labium visible; prothoracic process movable and when thrust into the socket on the mesosternum and forcibly snapped out causes the beetle to jump and click. Small to large mostly brown and black beetles. (Click Beetles.)... **Elateridæ** p. 392
   Prosternum not lobed; labium concealed; antennæ inserted on the front somewhat distant from the eyes; not able to jump and click. Small and rare beetles (*Eucnemidæ*) **Melasidæ** p. 394

14. Abdominal sternites 1 to 3 fixed and rigid; antennæ filiform; last tarsal joint as long as all the preceding together; claws very long and simple; body hairy. Small water beetles. (Long-toed Water Beetles.).......(*Parnidæ*) **Dryopidæ**
   Abdominal sternites free and movable; antennæ clubbed..................... 15

15. Posterior coxæ dilated into plates partially protecting femora, at least at the bases; antennæ inserted in front of the eyes; tarsi normal. Small convex scaly beetles usually feeding on dead or dry animal matter. (Skin or Larder Beetles.) **Dermestidæ** p. 404
   Posterior coxæ not dilated into plates partially protecting the femora, but flat and covered by femora in repose; antennæ inserted at the sides of the front; tarsal joints all but the last with membranous appendages. Slender often brightly marked pubescent flower-visiting beetles. (The Checkered Beetles.) **Cleridæ** p.388

LYCIDÆ. The Net-Winged Beetles.

The members of this family have usually been considered a part of the *Lampyridæ* in the past and are separated by the characters in the key. They are diurnal in habits and are predaceous. *Eros lætus* (Mots.) (Fig. 263) and *E. simplicipes* (Mann.) are small beetles, scarlet red above and black beneath, 8–11 mm. long, occurring in Northern California and ranging north into Oregon, Washington, British Columbia, and Alaska. *E. hàmatus* (Mann.) is similarly colored, 13 to 16 mm. long, and ranges in Alaska and British Columbia. *E. aurora* Hbst. is scarlet above and black beneath, 7–11 mm. long, and ranges throughout Europe, Siberia and much of North America. In the west it occurs in Alaska, British Columbia, Washington, Oregon, and Arizona. *Calopteron terminale* (Say) is 11–17 mm. long, black, the sides of the thorax and basal two-thirds of the elytra yellow, and the apical portion of the elytra purplish black. The head is

entirely hidden beneath the prothorax which is wider than long, and the elytra extend beyond the tip of the abdomen and are four times wider near the apex than at the base. It occurs on the foliage of plants near water and ranges from the east to California.

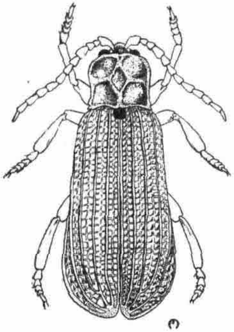

FIG. 263.—The net-winged beetle, *Eros lætus* (Mots.).

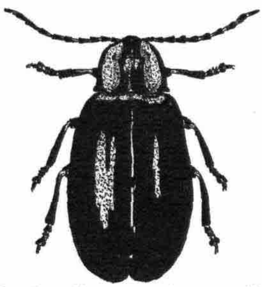

FIG. 264.—The common black lampyrid, *Lucidota fenestralis* (Melsh.).

LAMPYRIDÆ.[1] The Fire Flies, Glowworms.

These are the typical nocturnal fire flies so well known east of the Rockies but rare in the west. Our forms are mostly of the glowworm type in which the female is larvi-

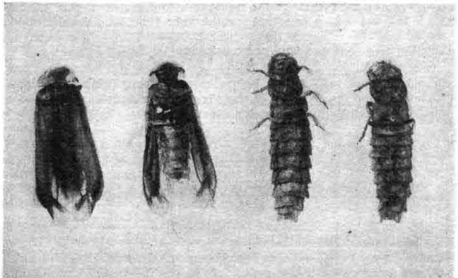

FIG. 265.—The pink glowworm, *Microphotus angustus* Lec. Males and adult apterous larviform females.

form and emits light, while the male is winged but not phosphorescent. One of the commonest western lampyrids is *Lucidota fenestralis* (Melsh.) (*Ellychina californica*

[1] E. C. Van Dyke, *Bul. Brooklyn Ent. Soc.*, 12, 1918, p. 1.
J. L. Leconte, "Syn. *Lampyridæ* of U. S." *Trans. Am. Ent. Soc.*, 9, p. 15, 1881–2.

Mots.) (Fig. 264), a black nonphosphorescent beetle, 7–16 mm. long, often with a purplish lustre and with two red, rosy, or yellow marks near the lateral margins of the prothorax. The head is completely hidden beneath the prothorax. The larvæ are flat, elongated, and black or dark brown with pink integument. They average 15–18 mm. in length. This species occurs in the canyons near creeks, and ranges from the east into Colorado, Arizona, California, and north into Oregon, Washington, and British Columbia. **The pink glowworm,** *Microphotus angustus* Lec. (Fig. 265), is larviform in the adult female stage, flattened, pinkish, and 10–15 mm. long. The elytra are vestigial with parallel lines and the antennæ are 9-jointed. The males are normally winged with pinkish bodies, the prothorax and elytra grayish brown, and the eyes black. The length is 10 mm. This interesting species occurs only in the dry grass on the foothills on very warm late summer and fall nights from June to August, and may be taken on but three or four nights during the average year in the San Francisco Bay region, California. The light is very bright and easily attracts attention. It is also reported in Oregon and Colorado.

Zarhipis piciventris Lec.[1] has large yellowish brown larviform females, 30–50 mm. long. They are often taken in the San Francisco Bay region. The males are 10 mm. long, piceous, the mandibles, prothorax, bases of antennæ, and legs reddish. *Z. riversi* Horn is 14 mm. long, black, with the face, palpi, thorax, scutellum, and abdomen except the black tip, all yellowish red. The females are larviform, yellowish, or brownish. The species occurs in the San Francisco Bay region, California.

CANTHARIDÆ (*Telephoridæ*).[2] The Leather-Winged Beetles.

This family comprises very common slender beetles with leathery wing covers, predaceous and diurnal in habits. *Podabrus comes* Lec. is 10–12 mm. long, has the head, prothorax, and margin of the posterior ventral segments yellow, the occiput sometimes dusky, and the elytra black with whitish pubescence. It feeds on aphis and is common in Arizona, California, Oregon, and Montana. *P. tomentosus* (Say) (*P. pruinosus* Lec.)[3] (Fig. 266) is 9–14 mm. long; head, prothorax, margin of abdomen, legs, and bases of the antennæ yellow; the elytra black with whitish pubescence giving a grayish blue color. The adults appear in May and continue throughout the summer. They fly freely about and drop to the ground if disturbed. The oblong pale yellow eggs, 0.36 mm. long, are laid in masses on or in the soil. The larvæ are 15–20 mm. long and pink, appearing velvety due to the covering of fine hair. The thoracic segments have two longitudinal dark lines on the dorsum. They live in the soil. Pupation occurs in a cell 3 to 6 inches deep in the soil and the pupæ vary from white, pink, or dusky depending upon the development. The adults freely feed on all kinds of aphis in the fields, gardens, and orchards, and are common in California, Oregon, and probably other Western States. *Cantharis divisus* (Lec.) (*Telephorus*) is a small species, 6–8 mm. long, black, the mouth reddish and the prothorax yellow, with two large black spots on the dorsum. It is a very common species during the spring months and feeds upon the many aphis infesting grasses, flowers, vegetables, fruit trees, and

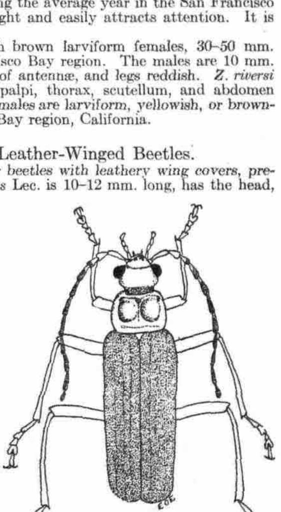

FIG. 266.—The downy leather-winged beetle, *Podabrus tomentosus* (Say).

[1] This and the following species are placed in the family *Phengodidæ* by Leng.

[2] J. L. Leconte, *Trans. Am. Ent. Soc.*, 9, p. 45, 1881–2.

E. C. Van Dyke, "Review of Genus *Silis* Latr. in Am. North of Mexico." *Jour. N. Y. Ent. Soc.*, 26, p. 161, 1918.

[3] H. F. Wilson, *Jour. Econ. Ent.*, 6, p. 457, 1913.

other plants. It has been particularly predatory on the apple-grain aphis, the melon aphis, the grain aphis, the rose aphis, and the green peach aphis in California. The species ranges north through Oregon, Washington, British Columbia, into Alaska, and is very beneficial. *C. consors* (Lec.) is 12–19 mm. long, light yellowish brown, with head, prothorax, base of antennæ, and legs reddish, the knees and tarsi of the legs piceous. It has been observed by the writer feeding in large numbers on the citrus mealybug on citrus trees in Southern California.

MELYRIDÆ (*Malachiidæ*).[1] Soft-Winged Flower Beetles.

The two-spotted collops, *Collops bipunctatus* Say, is 5 to 6 mm. long, the thorax rufous with two oblique black spots, the elytra bluish black, and the abdomen dusky. It ranges from Kansas to California and is reported as feeding on the larvæ of the alfalfa weevil in Utah.[2] **The striped collops,** *Collops vittatus* (Say), has wide bluish stripes on the elytra and the thorax is rufous with or without a small black discal spot. The adults and larvæ feed on the larvæ and chrysalids of the alfalfa caterpillar in Arizona.[3]

CLERIDÆ.[4] Checkered Beetles.

Cymatodera æthiops Wolcott occurs in Texas, Arizona, and New Mexico. The larvæ have been observed to feed on the caterpillars of the codling moth in New Mexico.[5] *Cymatodera ovipennis* Lec. is 8–11 mm. long, pale brown, the elytra with a pale line. The larvæ have been taken from the burrows of *Ipochus fasciatus* Lec., in Southern California.[6] The species is quite common throughout the State.

The cypress barkbeetle destroyer, *Enoclerus cupressi* Van Dyke,[7] is 7 x 2.5 mm., black, the elytra with a blue sheen and with triangular orange spots. It preys on the cypress barkbeetle, *Phlœosinus cupressi* Hopk., in California. *E. eximius* Mann. is 6.5 mm. long, black with whitish pubescence, the elytra bright red with three small basal and two apical black spots, and the abdomen red. It preys chiefly on the ptinid beetles infesting soft trees such as California bay, alder, willow, wax myrtle, and so forth, from California to British Columbia. *E. humeralis* Schaeffer has been reared from the cones of Douglas fir, infested with barkbeetles in California and Oregon. The beetle ranges north into British Columbia and south into Arizona. **The wasp-like clerid,** *Enoclerus sphegeus* (Fabr.), is 9 mm. long, the face yellow, the thorax and elytra dark brown or black, the latter with two apical whitish or yellow bands, the front represented by a few hairs, the median wide and subapical, small. The abdomen is red. The adults appear in May and June and search out the trees infested with the overwintering broods of barkbeetles. They are active on sunny days and feed chiefly on the adult barkbeetles. The eggs are deposited in the trees soon after the adults appear and the larvæ develop before the adult barkbeetles emerge. The larvæ are voracious feeders attacking the larvæ and pupæ of the hosts within the galleries under the bark. When full grown they migrate by night to the ground close to the bases of the trees and overwinter in cells made of debris and lined with a foam-like secretion, several inches below the surface. The beetles feed on barkbeetles belonging chiefly to the genus *Dendroctonus*. In Colorado *D. ponderosæ* Hopk. is specially attacked.[8] The

[1] Geo. H. Horn, "Syn. *Malachiidæ* of U. S." *Trans. Am. Ent. Soc.*, 3, p. 79, 1870; 4, p. 109, 1872–3.
Thos. Casey, "Syn. *Melyridæ* of N. A." *Ann. N. Y. Acad. Sci.*, 8, p. 456, 1895.
H. C. Fall, "Short Studies in *Malachiidæ*." *Trans. Am. Ent. Soc.*, 43, p. 67, 1917.
[2] F. M. Webster, Bul. 112, Bur. Ent. U. S. Dept. Agr., p. 31, 1912.
[3] V. L. Wildermuth, Bul. 124, U. S. Dept. Agr. p. 26, 1914.
[4] Chas. Schaeffer, "Notes on New *Cleridæ*." *Jour. N. Y. Ent. Soc.*, 16, p. 127, 1908. "N. A. *Cleridæ*." *Jour. N. Y. Ent. Soc.*, 25, p. 129, 1917.
A. G. Böving and A. B. Champlain, "Larvæ of N. A. *Cleridæ*." *Proc. U. S. Nat. Mus.*, 57, p. 575, 1921.
A. W. Wolcott, "N. A. Predaceous Beetles of the Tribe *Tillini*." *Proc. U. S. Nat. Mus.*, 59, p. 269, 1922.
[5] D. E. Merrill, *Jour. Econ. Ent.*, 10, p. 461, 1917.
[6] F. E. Blaisdell, *Insect Life*, 5, p. 33, 1892.
[7] E. C. Van Dyke, *Bul. Brooklyn Ent. Soc.*, 10, 1915, p. 29.
[8] A. G. Böving and A. B. Champlain, *Proc. U. S. Nat. Mus.*, 57, 1921, p. 632.

beetle is also recorded in Wyoming, Montana, Utah, Idaho, British Columbia, California, and New Mexico, and probably occurs in all the other Western States as well, *Trichodes ornatus* Say is 6–7 mm. long, of a metallic bluish color, the elytra with three irregular yellow bands, and the tibiæ usually pale. The larvæ are 13 mm. long, yellow with heavily chitinized parts dark brown. They prey on the larvæ of bees and wasps and the adults feed on the pollen of flowers. It is a western species occurring in most of the States. *Hadnocera scabra* Lec. is 4–5 mm. long, dull brownish gray, with roughened hairs on the dorsum. It is quite common in Southern California and has been reported to feed on the woolly apple aphis by D. W. Coquillett.[1] It ranges north into Washington.

CORYNETIDÆ.

These beetles are separated from the *Cleridæ* by the heteromerous tarsi due to the atrophied fourth joint. *Phyllobænus merkeli* Horn is predaceous on *Phlæosinus* spp., under bark in New Mexico, Arizona, and California. *Chariessa elegans* Horn is 11.5 mm. long, pale red, the elytra bluish black, the antennæ red at base, and the remainder black. The larvæ prey upon various wood borers including the cerambycid, *Neoclytus conjunctus* (Lec.), in Arizona, California, and Oregon.

The red-legged ham beetle, *Necrobia rufipes* (De Geer), is 4.5 x 2.5 mm. long, iridescent peacock green or steel blue, with the bases of the antennæ and the legs red. The head and prothorax are covered with fine hairs and the elytra finely striate. The eggs are white and the larvæ are brown or ochræous, with head and thorax darker, somewhat hairy, 10 mm. long. It is a cosmopolitan species commonly found, usually in spoiled meat, fish, and cheese, but occasionally also in cured hams and bacon. In the past it was thought to feed directly on the meat, but more recent investigations indicate that the adults and larvæ are predaceous on other carrion and scavenger insects, particularly the fly maggots which commonly infest the above mentioned products. *N. ruficollis* (Fabr.) is red, the head, antennæ, and abdomen black; the elytra blue or green with red base. *N. violacea* (Linn.) is blue or green with the legs and antennæ dark. All are cosmopolitan and found throughout our territory.

MELOIDÆ.[2] Blister Beetles.

The larvæ undergo several more changes than most beetles, including a propupal following three or four larval forms. Some are beneficial being predaceous on the eggs of grasshoppers, while others are injurious living in the nests of bumble and other wild bees and feeding upon the honey. Serious infestations may be controlled by dusting with calcium cyanide or arsenate of lead.

The spotted blister beetle, *Epicauta maculata* (Say), is black, covered with fine whitish hairs excepting in many small spots where the black shows distinctly. It is injurious to many crops such as alfalfa, beets, beans clover, potatoes, other vegetable and field crops, and native plants. It is specially abundant at times, and injurious in Colorado, Montana, Idaho, New Mexico, and ranges into California, Oregon, Washington, and British Columbia. **The white spotted blister beetle,** *Epicauta pardalis* Lec., is 10

[1] *Insect Life*, 4, p. 260, 1892.

[2] H. C. Fall, "Notes on *Cantharis* with Synoptic Table." *Trans. Am. Ent. Soc.*, 27 p. 293, 1901.

F. H. Chittenden, Bul. 43, Bur. Ent. U. S. Dept. Agr., p. 21, 1903.

C. Wellman, "Classification of the *Lyttidæ*." *Ent. News*, 21, p. 211, 1910.

mm. long, black with many short white lines and spots over the whole dorsum. It is a common Mexican species ranging north into New Mexico, Arizona, California, and Oregon. It is often abundant in grasses and weeds and freely attacks corn, potatoes, and other crops. **The black blister beetle,** *Epicauta pennsylvanica* (De Geer), is wholly black and 7–13 mm. long. It ranges from Mexico throughout much of the United States and occurs in New Mexico, Colorado, and Montana in the west. The adults ordinarily visit goldenrod, ironweed, ragweed, and pigweed, but are sometimes injurious to beets, cabbage, carrots, corn, mustard, potatoes, tomatoes, and other crops. **The punctured blister beetle,** *Epicauta puncticollis* (Mann.), is a small black beetle, 7–11 mm. long, with bluish sheen. The entire surface is minutely and densely punctured. It commonly feeds on tarweeds, but also attacks flowers, corn, potatoes, and other crops. It ranges from Southern California into Oregon, Washington, Idaho, and British Columbia, and appears most injurious in the more northern range. **The striped blister beetle,** *Epicauta vittata* Fabr., is 12–14 mm. long, blackish, each elytron bordered yellow and with a yellow median stripe. It is a common species ranging west into Montana, and is injurious to alfalfa, beans, beets, clover, corn, melons, peas, potatoes, radishes, tomatoes, turnips, and other crops. **The immaculate blister beetle,** *Macrobasis immaculata* (Say), is a cinereous, pubescent gray or yellow species, often a serious pest to beets, cabbage, potato, tomato, and other crops in Colorado, New Mexico, and the east. *M. albida* (Say) is similar in color with two narrow black lines on the prothorax. It also attacks vegetable crops in Colorado. **The long blister beetle,** *Macrobasis longicollis* (Lec.), is a large species uniformly clothed with yellow pubescence. It is indigenous to New Mexico, Arizona, and Texas, and is at times very abundant and destructive to field and truck crops. **The ash-gray blister beetle,** *Macrobasis unicolor* (Kirby), is ashy gray and 10 to 15 mm. long. It is a very common eastern species, the adults being often destructive to forage and truck crops. The beetle ranges west into Arizona, Colorado, and Idaho, and often appears in large numbers in the areas where grasshoppers breed and where the young undoubtedly feed on grasshopper eggs. **The green blister beetle,** *Lytta cyanipennis* (Lec.), is 13–18 mm. long, green or purplish blue. The adults are general feeders on leguminous crops and the larvæ on grasshopper eggs. The species ranges throughout the west, being known in Wyoming, Utah, Montana, Washington, British Columbia, Oregon, and California. **Nuttall's blister beetle,** *Lytta nuttalli* (Say), is 16–28 mm. long, metallic green or purplish. It is a large, ravenous western species with habits much like the preceding. It is known in New Mexico, Colorado, Wyoming, Montana, and Idaho, being confined largely to the Rocky Mountain region. **The infernal blister beetle,** *Lytta stygica* (Lec.) (Fig. 267), is iridescent bright green to bluish black and

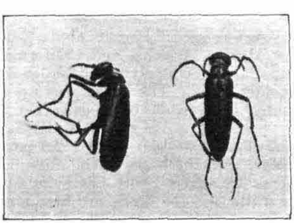

FIG. 267.—The infernal blister beetle, *Lytta stygica* (Lec.).

9–14 mm. long. It is a common Pacific Coast species, appearing in the spring and feeding on wild flowers, California poppy, iris, dog fennel, and weeds, later often occurring on ornamentals and native shrubs. It ranges in California, Oregon, and Washington. *Lytta insperata* (Horn) is 15–20 mm. long, black throughout and often injurious to sugar beets in Southern California.

The soldier beetles, *Tegrodera erosa* Lec. (Fig. 268) and *T. latecincta* Horn, are very extraordinary arid and desert species occurring in Arizona and California. They are 17–30 mm. long; the head red; the prothorax dusky

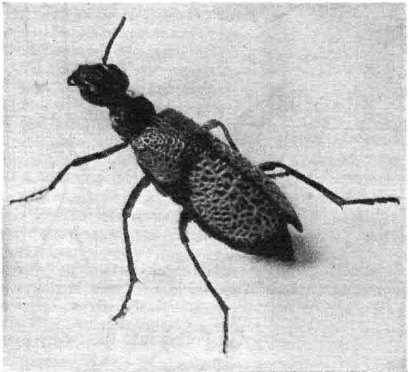

FIG. 268.—The soldier beetle, *Tegrodera erosa* Casey.

red; the antennæ, legs, and remainder of the body shining black; and the elytra golden yellow, reticulated, and with black margins, a black median belt, and black apices. In the former species the black markings of the elytra are very obscure, while on the latter they are strongly pronounced. The beetles ordinarily feed upon the native sage brush, artemisia, and other plants, but frequently invade alfalfa fields and do much damage.

ANTHICIDÆ.[1] Ant-Like Flower Beetles.

The fruit notoxus, *Notoxus constrictus* Casey (Fig. 269), is a very peculiar fawn-colored beetle, 3–4 mm. long, with a wide median and narrow apical black band on the elytra, and the prothorax prolonged over the head into a somewhat forked horn, while the head is carried at right angles to the main axis of the body. The species is common in the orchards of all parts of California and often feeds on the injured fruit in the orchards and on the cut fruit in the dry yards, but is not a pest in that the larvæ do not

[1] Thos. Casey, "Syn. of *Anthicidæ* of U. S." *Ann. N. Y. Acad. Sci.*, 8, p. 624, 1895. H. C. Fall, "N. A. Species of *Notoxus*." *Bul. Brooklyn Ent. Soc.*, 11, p. 33, 1916.

breed in the dried fruit. It has been taken on apples, apricots, cherries, peaches, plums, and prunes, and is also injurious to young eggplants. *N. calcaratus* Horn has similar habits in Southern California and ranges into New Mexico; *N. monodon* Fabr. ranges throughout the United States. J. B. Gill has observed it feeding on the pupæ of *Archips argyrospila* Walker

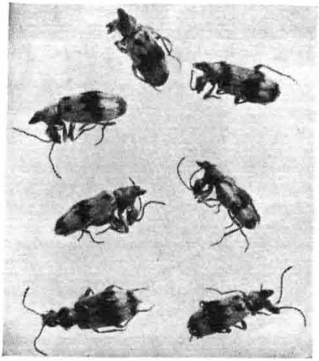

FIG. 269.—The fruit notoxus, *Notoxus constrictus* Casey.

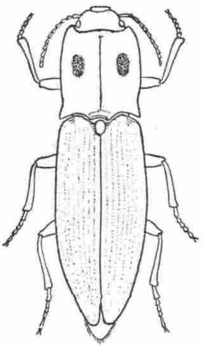

FIG. 270.—The western eyed elater, *Alaus melanops* Lec.

in Colorado.[1] It is also recorded as boring into the twigs of apple trees in Southern California.

ELATERIDÆ.[2] Click Beetles, Wireworms.

This family is a large one, containing many injurious species.

The eyed elater, *Alaus oculatus* (Linn.) is a large shining black species 28–45 mm. long, with two large oval, conspicuous eye-like spots on the dorsum of the prothorax surrounded by a ring of whitish scales, the elytra striated and the whole dorsum covered with scattering white scales. The adults frequently occur about rotten logs or stumps. The larva is smooth, cylindrical, yellowish, 50 to 63 mm. long, and lives in dead and decaying wood and are predaceous on the larvæ of wood boring beetles. The species is eastern and ranges west into Montana. This species is replaced in the west by *Alaus melanops* Lec. (Fig. 270), a dull black species lacking the white scales around the eye-spots and on the pronotum. It is also smaller, averaging from 28–35 mm. in length. The larvæ are 35 mm. long, yellowish

[1] Bul. 116, pt. 5, Bur. Ent. U. S. Dept. Agr., p. 102, 1913.

[2] F. Blanchard, "Rev. of *Cardiophorus*." *Trans. Am. Ent. Soc.*, 16, p. 1, 1889. Chas. Schaeffer, New Western Species. *Jour. N. Y. Ent. Soc.*, 24, p. 256, 1916, J. A. Hyslop, "Phylogeny Based on Larval Characters." *Ann. Ent. Soc. Am.*, 10, p. 241, 1917. "Genotypes of the *Elateridæ* of the World." *Proc. U. S. Nat. Mus.*, 58, p. 621, 1921.

with the head and thoracic segments dark brown. It ranges from New Mexico and Southern California to British Columbia. *Alaus lusciosus* Hope is a large robust species 45 mm. long, velvety black with circular eye-spots, much of the sides of the prothorax and large blotches on the elytra made up of yellowish white scales. It occurs in Arizona. *Chalcolepidius smaragdinus* Lec. is a most brilliant green species occurring on willow in Arizona and Southern California.

The sugar beet wireworm, *Pheletes californicus* (Mann.) (*Limonius*),[1] is elongate, light or dark brown, 10 mm. long, clothed with short fine hair and coarsely punctured on the dorsum. The females leave hibernation in the spring and lay the small elliptical white eggs in the soil. The eggs hatch in from fifteen to thirty-three days. The larvæ are typical, cylindrical, shiny yellowish brown wireworms (Fig. 271). They are root feeders attacking chiefly young plants, but also working up the stems of older ones. They are serious pests to young sugar beets and beans throughout California, and also attack alfalfa, corn, dock, mustard, pigweed, potato, chrysanthemum, asters, and other native and cultivated plants. The larvæ require about three years to develop and a complete life cycle covers four years. The larvæ also often occur in rotten logs. The species ranges north into Washington. The predaceous ground beetles kill many of the larvæ. Control measures consist in clean cultivation, early planting, and good care. *P. canus* (Lec.) is a similar species ranging from Southern California into British Columbia. *Limonius infuscatus* Mots. is often associated with the two preceding species, affects practically the same crops, and is specially serious as a pest to potatoes in sandy river bottom land. *L. discoideus* Lec. is known in Oregon and British Columbia as the **bud click beetle** because of the injury by the adults to the buds and blossoms of apple, cherries, pears, plums, and other fruit trees. It ranges south into California and east into Colorado. *Ludius hieroglyphicus* (Say) (*Corymbites*) is 11–13 mm. long, the head and thorax bronzy black clothed with whitish yellow pubescence, the elytra dull yellow with dark cross bands and reddish brown

FIG. 271.—Typical infestation of wireworms in a seed tuber of a dahlia. This tuber was exhumed one week after planting.

[1] J. E. Graf, Bul. 124, Bur. Ent. U. S. Dept. Agr. 1914.

legs. It is an eastern species reported to feed on the buds and young leaves of apple in British Columbia.[1] **The inflated wireworm,** *Ludius inflatus* (Say),[2] is a robust slate gray or almost black species 8–11 mm. long. The larvæ are 13 mm. long, pale yellow, and somewhat flattened. They are serious pests to seedlings of barley, corn, oats, wheat, and potatoes, while the adults feed on the buds and petals of wild roses, apple trees, and eat the

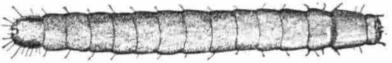

FIG. 272.—A wireworm or larva of a click beetle.

kernels of seed wheat on the ground. The species is particularly injurious in British Columbia, Washington, Oregon, and Idaho, but also occurs in California, Arizona, New Mexico, and Eastern States. **The dry land wireworm,** *Ludius noxius* Hyslop,[3] is a slender black beetle 13 mm. long, while the larvæ are yellow and of the same length. It has habits similar to the preceding and occurs in the dry areas east of the Cascades in Washington, Oregon, and Idaho, where cereals are chiefly injured. **The potato wireworm,** *Dolopius lateralis* Esch., is a slender, dark reddish brown species 7 mm. long. The larvæ are yellow and often serious pests to potatoes. The adults frequent orchards. The species ranges from the east into British Columbia, Oregon, Arizona, and California. There are a number of synonyms for this beetle.

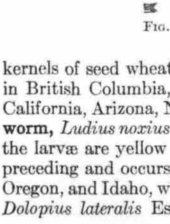

FIG. 273.—The click beetle, *Ludius nigricollis* (Bland) (*Corymbites*). Colorado.

Melanactes densus Lec. is a very common, large shining black beetle 21 mm. long, with striated elytra. It occurs throughout California. *Cardiophorus fenestratus* Lec. is 6–7 mm. long, shining black with four pubescent spots on the elytra. It is sometimes a pest to buds and blossoms of fruit trees in the northwest. It occurs in British Columbia, Washington, Oregon, California, Nevada, Utah, Colorado, Montana, and eastward.

MELASIDÆ (*Eucnemidæ*).

Melasis rufipennis Horn[4] is 8 to 12 mm. long, the elytra and antennæ reddish, and the remainder blackish. The larvæ are yellowish with the first thoracic segment the widest, flat, and the mouth parts well developed and dark brown. When mature they are 26–29 mm. long. They honeycomb the wood of living trees with flat burrows. The adults emerge about the middle of April. The lowland and white firs are attacked in Oregon, Washington, California, and Nevada.

[1] W. H. Brittain, *Proc. B. C. Ent. Soc.*, p. 14, 1912.
[2] J. A. Hyslop, Bul. 156, U. S. Dept. Agr., p. 10, 1915.
[3] J. A. Hyslop, Bul. 156, U. S. Dept. Agr., p. 12, 1915.
E. C. Van Dyke, considers this a variety of *Ludius pruininus* (Horn), an eastern species also known in California.
[4] W. J. Chamberlin, *Jour. N. Y. Ent. Soc.*, 28, p. 154, 1920.

BUPRESTIDÆ.[1] Metallic Wood Bores, Flat-Headed Borers.

This is a large family of beautiful metallic beetles, chiefly injurious to native and introduced fruit, shade, ornamental, and forest trees and shrubs. The larvæ are known as flat-headed borers because of the greatly enlarged and flattened thoracic segments. Control measures,[2] are quite difficult. The arsenical sprays can be used for the leaf-eating adults and the oil sprays for killing the eggs laid on the bark. Removing and burning the infested parts of trees, and digging out the larvæ may be of some value. Whitewashing, tree wrappers, and protectors afford considerable protection against egg-laying. Special methods are given under the more important injurious forms.

The placid buprestid, *Chrysophana placida* (Lec.), is a small species, 8–10 mm. long, entirely metallic green or often with a bronze iridescent line in the middle of each elytron. The larvæ mine the cones and wood of normal, injured, or dead trees of white, sugar, single leaf, yellow, and knobcone pines, mountain hemlock, Douglas fir, alpine, white and red firs, and red cedar. The species is destructive to the seed crop of the knobcone pine and has been reared from window and door casings made from sugar pine. The adults fly from March to August. Hibernation is in the pupal stage. The range includes Washington, Oregon, California, Nevada, Utah, Colorado, Arizona, and New Mexico.

The California buprestid, *Polycesta californica* Lec., is 13 mm. long, black, coarsely punctured, and the elytra with coarse striæ. The larvæ mine dead and dying forest, shade, ornamental, and fruit trees, including white alder, cottonwood, oaks, mountain mahogany, almond, apple, pear, California Christmas berry, red bud, maple, and manzanita. The species occurs in California, Oregon, and Alaska. *P. elata* Lec. mines dying and dead oak, red bud, sycamore, and other shade trees in Arizona. *P. velasco* Cast. mines injured, dying and dead cat's claw, mesquite, and palo verde in Arizona, California, New Mexico, and Texas.

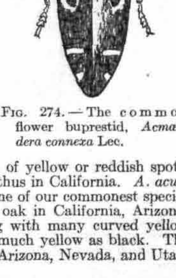

FIG. 274. — The common flower buprestid, *Acmæodera connexa* Lec.

Members of the genus *Acmæodera*[3] are largely black with bright yellow orange or red markings on the elytra, and covered with soft pubescence. The adults commonly visit flowers. *Acmæodera amabilis* Horn is 8–11 mm. long with the apical spot mostly red. It mines dead wood of mountain alder in Arizona and New Mexico. *A. angelica* Fall is 6.5–9 mm. long, the elytra with 4 transverse series of yellow or reddish spots. It mines injured, dying or dead oak, poison oak, and ceanothus in California. *A. acuta* Lec. is 5–9 mm. long with similar yellow markings. It is one of our commonest species and attacks injured, dying and dead wood of native blue oak in California, Arizona, and Utah. *A. connexa* Lec. (Fig. 274) is 8–13 mm. long with many curved yellow lines and spots on the elytra, there being present often as much yellow as black. The larvæ mine the injured wood of oaks in Oregon, California, Arizona, Nevada, and Utah.

[1] W. J. Chamberlin, "*Buprestidæ* of Northern California." *Ent. News*, 28, pp. 129, 166, 1917.

H. E. Burke, "Flat-headed Borers Affecting Forest Trees in the U. S." Bul. 437, *Prof. Paper*, U. S. Dept. Agr. 1917. "Western *Buprestidæ*." *Jour. Econ. Ent.*, 10, p. 329, 1917; 11, p. 209, 1918. *Proc. Ent. Soc. Wash.*, 22, p. 72, 1920.

A. S. Nicolay and H. B. Weiss, "Review of the genus *Buprestis* in N. A." *Jour. N. Y. Ent. Soc.*, 26, p. 75, 1918. "Group *Traches* in N. A." *Jour. N. Y. Ent. Soc.*, 28, p. 136, 1920.

[2] H. E. Burke, *Jour. Econ. Ent.*, 10, p. 332, 1917.

[3] H. C. Fall, "Synopsis of Species of *Acmæodera* of N. A." *Jour. N. Y. Ent. Soc.*, 7, p. 1, 1899.

The species is common in the Sierras. *A. cuneata* Fall is 8–10 mm. long with as many, or more, yellow marks as black on the elytra. It mines injured and dead wood of mountain alder in Arizona and Utah. *A. hepburni* Lec. is 8.7–12 mm. long, very densely pubescent, and mostly yellow on the elytra with black predominating posteriorly. The larvæ mine injured or dying pear and other fruit trees, as well as oak trees throughout California. The adults appear in May and June. *A. mariposa* Horn is 7–8.5 mm. in length, the elytra with three reddish spots behind the middle. The adults feed on the foliage and the larvæ mine injured and dying mountain mahogany, California Christmas berry, ceanothus, poison oak, California coffee berry, and red bud in the mountains of California and Oregon. The adults appear from April to June. *A. van dykei* Fall is 9–12 mm. long and has a few mostly lateral small orange spots on the elytra which tend to coalesce into bands. It mines ceanothus and the injured roots of live oak in California, Washington, Nevada, and Utah. The adults appear from May to July.

The sculptured pine borer, *Chalcophora angulicollis* (Lec.) (Fig. 275), is a large species 25–28 mm. long, shining dark brown or black, with numerous irregular sculptured areas on the dorsum bronze, and the venter iridescent bronze. The larvæ attack yellow pine, Douglas fir, white fir, and grand fir in British Columbia, Washington, Idaho, Oregon, California, New Mexico, and Colorado.

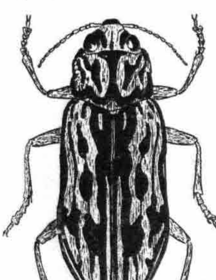

FIG. 275.—The sculptured pine borer, *Chalcophora angulicollis* (Lec.).

The emerald juniper borer, *Trachykele blondeli* Marseul, is one of the most beautiful beetles, being a rough bright iridescent green with golden reflections. It is 14–17 mm. long, and mines living, injured, dying and dead western juniper, Monterey cypress, Macnab cypress, Sargent cypress, red cedar or giant arborvitæ in Washington, Oregon, California, and New Mexico. The adults fly from April to August. *T. opulenta* Fall is similar but the surface is less rough and the disk of the elytra is marked with small velvety black spots; it is 16–20 mm. long. It attacks the wood and bark of incense cedar and red cedar in the higher mountain regions of California, Oregon, and Washington, and the giant sequoia in California. *T. hartmani* Burke is stout, 22 mm. long, brownish bronze, the elytra iridescent with black velvety depressions. The larvæ are very slender, translucent white, smooth, and 10-jointed. They mine the wood of Sargent cypress in California. *T. nimbosa* Fall is a dull bronze or gray species 15–17 mm. long, more or less pubescent and with velvety black spots on the elytra. The larvæ require two or three years to mature and usually enter living trees through old wounds. The adults fly in April, May, and June. The species infests red fir, white fir, mountain hemlock, juniper, incense cedar, cypress, and the giant sequoia, and ranges in California, Oregon, Washington, and British Columbia.

The members of the genus *Dicerca* are dull bronze, medium-sized, with the tips of the elytra drawn out or prolonged. *D. crassicollis* Lec. (*D. californica* Cr.) is bronze-gray or brownish and 17 mm. long. The larvæ mine Douglas fir in California, Oregon, and Washington. **The flat-headed cherry tree borer,** *Dicerca divaricata* (Say), is brassy brown or grayish, 16–21 mm. long. The larvæ infest the cherry in British Columbia and also occur in Colorado. The species is widely distributed throughout North America and is represented under many synonyms. It infests cherry and beech in the east. *Dicerca horni* Crotch is a common destructive pest in the west. It is 12 mm. long and of a bronze color, with small black narrow broken ridges on the dorsum. The larvæ are 37 mm. long. They mine injured, dying and dead alder, buckeye, buckthorn, cherry, bird cherry, California coffee berry, ceanothus, madrona, mountain mahogany,

oak, peach, plum, prune, poison oak, snowberry, sumach, sycamore, and English walnut, The adults fly from April to September. The range includes Montana, Idaho, Washington, Oregon, and California. *D. pectorosa* Lec. is robust rough, blackish bronze in color. 12–16 mm. long. The larvæ resemble those of the western flat-headed apple tree borer but are larger, measuring 25 mm. They mine peach, prune, and wild plum trees, and particularly infest the areas around the burrows of the western peach borer, *Ægeria opalescens* H. Edw., in Oregon and California. Lodgepole pine is listed as a host by W. J. Chamberlin. The range also includes Idaho, Nevada, and Utah. *Dicerca prolongata* Lec. is of a shining bronze and copper color, 23 mm. long, with the elytra much prolonged at the tips. The larvæ mine cottonwood, poplar, and cherry. The range includes much of North America. In the west the species occurs in the higher mountains of British Columbia, Washington, Oregon, California, Nevada, Montana, Wyoming, Colorado, and New Mexico. *D. sexualis* Crotch is 16 mm. long, bronze or copper, with a number of well defined linear ridges on the elytra and prothorax. It mines Douglas fir, knobcone pine, and yellow pine in New Mexico, Arizona, California, Oregon, and Washington. *D. tenebrosa* (Kirby) is 17–19 mm. long, dark bronze or gray, with numerous short linear shiny black ridges on the dorsum, and reddish copper beneath. It mines dead white fir, lodgepole pine, and yellow pine in California, Nevada, Oregon, and Eastern States.

The poplar borer, *Pœcilonota*[1] *cyanipes* (Say), is 11–15 mm. long, iridescent brassy or bronzy above, the sharp prolongations of the elytra tipped with copper. The body is plainly punctate and the elytra finely striate. The adults fly in August and September. The larvæ mine injured wild and ornamental poplars in the Eastern States and in Colorado and New Mexico. The variety *californica* Chamberlin usually attacks young aspen in California, Oregon, Utah, and Idaho. *P. fraseri* Chamberlin breeds only in willow and ranges from British Columbia to northern California (Van Dyke). *P. thureura* (Say) flies in July and August and mines living wood of older native and ornamental cottonwood trees in Montana and Oregon. *P. montanus* Chamberlin also mines the same host in Montana. The latter is 15–17.5 mm. long, dark brassy green almost black or grayish.

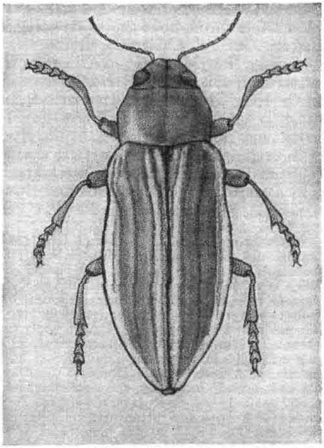

FIG. 276.—The aurulent beetle, *Buprestis aurulenta* Linn. A beautiful green beetle, the elytra bordered with gold or copper.

Members of the large genus *Buprestis* are medium-sized with small rounded scutellum, the elytra usually striated and often marked with yellow. **The adject buprestid,** *B. adjecta* (Lec.), is a rather short, robust,

[1] W. J. Chamberlin, "Review of *Pœcilonota* in N. A." *Jour. N. Y. Ent. Soc.*, 30, p. 52, 1922.

entirely metallic green species 13–18 mm. long, the suture and lateral margins of the elytra cupreous and the tips bidentate. It is a rather rare alpine species which mines the Jeffrey, lodgepole, and yellow pines in British Columbia, Washington, Oregon, California, Nevada, Idaho, Colorado, Wyoming, New Mexico, and is also recorded in Oahu, H. T. The adults fly from July through September. **The aurulent beetle,** *Buprestis aurulenta* Linn. (Fig. 276), is the most beautiful of the common mountain species. The adults are 14–19 mm. long, iridescent green or bluish, the median suture and margins entirely bordered with copper. There are at least nine synonyms. It is similar to the preceding species, but has every other elytral striæ suppressed and has a wider marginal gold band. It mines injured, dying and dead Douglas fir which is the preferred host, as well as red cedar, Colorado blue spruce, Sitka spruce, digger pine, Jeffrey pine, lodgepole pine, Monterey pine, sugar pine, white pine, and yellow pine. The larvæ pupate and transform into adults in the summer and early fall which hibernate in the pupal cells and emerge the following spring and summer. The larvæ are particularly injurious to lightning-struck, fire-scorched, blazed, or wounded trees. The species is common in the high mountains throughout the west, being known in British Columbia, Washington, Oregon, California, Idaho, Nevada, Montana, Wyoming, Utah, Colorado, New Mexico, and Arizona. H. E. Burke [1] has reported the larvæ of the colydid beetle, *Deretaphrus oregonensis* Horn, preying on the larvæ in Oregon. **The confluent buprestid,** *Buprestis confluenta* Say, is one of the most beautiful and rarest beetles. The adults are 14.5–16 mm. long, bright emerald green or bluish, the elytra thickly and confluently spotted with bright yellow. The male has a wide yellow band on the venter. They fly from July through September. The larvæ mine injured and dead poplar and aspen throughout the United States. The species ranges west into Colorado, Wyoming, Utah, Nevada, California, and British Columbia.

Buprestis connexa Horn is 15 mm. long, brilliant green, the dorsum of the head, pronotum, and margins of the finely striated elytra cupreous. It is an alpine species flying from July through September, and mining the cambium and sapwood of stumps and felled trees of Jeffrey and yellow pines in California, Oregon, Idaho, and Nevada. *B. fasciata* Fabr. is 15–19 mm. long, iridescent blue green, the female immaculate or with from two to six yellow or orange spots and the male always with six spots on the elytra. The middle pair of spots is very much wider than the others. The phase known as *langi* (Mann.) is almost entirely brilliant green and is but the female of the western form. It mines Douglas fir and yellow pine in every Western State from Alaska to Southern California, and from the Pacific Ocean to the Rocky Mountains. *B. gibbsi* (Lec.) is a rare alpine species 15 mm. long, the elytra purplish with two transverse pale spots, and two apical partially orange spots on the elytra. It mines the solid heartwood of old fire scars or dead logs of oak and cottonwood in California, Oregon, Washington, and Colorado. *B. læviventris* (Lec.) is 14–20 mm. long, black or very dark brown with a somewhat broken longitudinal yellow or orange line or row of spots on the middle of each elytron in series of four divisions or spots. The front of the head and the extreme front marginal tip of the pronotum are also yellow orange, and there are two orange spots on the venter of the last abdominal segment. It mines injured and dead yellow pine which is the primary host, also digger, lodgepole, and Monterey pines, and aids in destroying stumps. It prefers old dry logs and poles without bark, and occurs in Washington, Oregon, California, Idaho, and Arizona. A number of parasites have been reported preying upon it in California by H. E. Burke.[2] **The rustic beetle,** *Buprestis maculiventris* Say var. *rusticorum* (Kirby), is 15–23 mm. long, black with purplish iridescence, punctate and

[1] *Ent. Soc. Wash.*, 21, 1919, p. 124.
[2] *Proc. Ent. Soc. Wash.*, 19, p. 87, 1917; 21, p. 124, 1919.

striate, with parts of the head, the anterior angles of the pronotum, and the venter of the last abdominal segment mostly orange, and often with a pair of lateral orange spots on the three preceding segments. The adults fly from May through October and frequently feed on the needles of the yellow pine. The larvæ mine dying and dead Douglas fir, white fir, alpine fir, grand fir, and yellow pine in New Mexico, Colorado, Idaho, Utah, Nevada, Arizona, California, Oregon, Washington, and British Columbia, and occur throughout much of North America. The variety *subornata* (Lec.) differs from the preceding by having a more uniform green or violet hue and by having two discordal ventral abdominal spots more or less connected with the lateral ones. It mines Douglas fir and yellow pine in Colorado, New Mexico, Montana, Utah, Oregon, and California. *Buprestis viridisuturalis* Nicolay and Weiss is 11–22 mm. long, the head, thorax, and venter bright metallic green, the elytra yellow with large irregular median line embracing the sutures and widest near the apex, the tips being rufous. The larvæ mine dead areas in living trees of poplar, cottonwood, and white alder in California and Oregon.

The members of the genus *Melanophila* are rather small flat black, green, or bronze species, often with yellow spots on the elytra. *Melanophila acuminata* (De Geer) is 10–12 mm. long and black throughout. The adults fly from May through October, are common in the smoke of forest fires, and often severely bite the woodsmen, being the worst species in this respect. The larvæ mine the bark and outer wood of injured, preferably fire-scorched, and dead resin pine, lodgepole pine, yellow pine, Monterey cypress, Engelmann spruce, Sitka spruce, Douglas fir, grand fir, and red cedar in New Mexico, Colorado, Idaho, Washington, British Columbia, Alaska, Oregon, California, Siberia, Europe, and much of North America. *M. consputa* Lec. is 8–13 mm. long, black, usually with 12 small yellow spots on the elytra. The adults fly from April through October and often alight on the necks, arms, or hands of woodsmen in logging camps or about mill ponds, and bite severely. The larvæ mine the inner bark and outer wood of injured, dying and dead knobcone, lodgepole, Monterey, and yellow pines in Arizona, California, and Oregon. Pupation occurs in the bark or wood in spring and summer. **The western hemlock bark borer,** *Melanophila fulvoguttata* (Harris) [*M. drummondi* (Kirby)], is 9–11 mm. long, dull or shining black or bronze, immaculate or often with 6 yellow spots on the elytra of which the anterior is usually the largest. The adults fly from May through September. The larvæ excavate shallow, winding burrows in the inner bark and outer wood of normal, injured, and recently filled trees, are common and destructive, causing "gum spot" defects in living trees, and often killing the largest and best trees. Pupation occurs from February through June. Alpine fir, Douglas fir, grand fir, noble fir, red fir, white fir, mountain hemlock, western hemlock, western larch, yellow pine, Engelmann spruce, and Sitka spruce are attacked. Spruce is the preferred host. This species is palæarctic and in the west ranges from Alaska into every Western State. *Melanophila californica* Van Dyke is similar to the preceding in being either immaculate or having 6 yellow spots, but is smaller and more flattened, bronze above and green beneath. The adults fly from May through August. The larvæ mine the inner bark and outer wood of healthy, injured, or dead bigcone, digger, Jeffrey, knobcone, Monterey and yellow pines, Douglas fir, and bigcone spruce. Pine trees are preferred. The species kills many second-growth trees and assists the barkbeetles in the destruction of others. Pupation occurs from March through July. It is known in California, Oregon, and Idaho. *M. gentilis* Lec. is 13 mm. long and metallic bluish green in color. The adults fly from March through August and pupation occurs from March through July. It is a very serious and destructive forest beetle. The larvæ mine the inner bark and wood of normal, injured, and dead trees, killing small and large trees alike, and are particularly injurious to the second growth in some localities. Sugar pine is the preferred host, but the beetle also attacks Jeffrey and yellow pines and ranges throughout the Pacific Coast and Rocky Mountain States. *M. intrusa* Horn is 8 mm. long, bronzy black above and brassy beneath. It mines the inner bark and outer wood of injured and dead knobcone, sugar, and yellow pines in Colorado, Nevada, and California. Pupation occurs from March through June, and the adults fly in June and July. *M. pini-edulis* Burke is 6.5 mm. long, bronzy, covered with gray pubescence, and with 3 pairs of yellow spots on the elytra. The larvæ mine the bark and outer wood of the limbs and trunks of normal, dying and dead piñon pine in Colorado, Utah, and Arizona.

The common anthaxia, *Anthaxia æneogaster* Castelnau and Gory, is but 4–5 mm. long, quite flat, dull bronzy black above and brassy green beneath. The adults fly from March through September. The larvæ mine the bark and outer wood of normal,

injured, dying and dead trees and shrubs, and commonly live in the branches of large trees and in the main trunks of small trees and shrubs which are often killed. Among the hosts are Douglas fir, mountain mahogany, Garry and white oak, digger, Jeffrey, knobcone, Monterey, piñon, sugar, and yellow pines, red bud, redwood, wild rose, service-berry, California black walnut, and willow. It is the commonest species throughout the Pacific Coast and Rocky Mountain states. *A. deleta* Lec. is at times common in ceanothus in California and also occurs in Colorado.

The large genus *Chrysobothris*[1] embraces many destructive species, the larvæ of which are commonly known as flat-headed borers. The adults are medium sized, broad and flat, the front femora strongly toothed, and the first joint of the hind tarsi as long as or longer than the next three. *C. californica* Lec. is 10–19 mm. long, and dark cupreo-æneous. It infests pines in the middle Sierras of California and Nevada. *C. caurina* Horn is 8–11 mm. long, dark bronze, the punctured spaces coppery or green. It mines Douglas fir, yellow pine, and white pine in Colorado, Nevada, California, and Oregon. *C. debilis* Lec. is 5–8 mm. long, dark brownish or blackish bronze. It mines bark of wood of dying and dead mesquite, oak, palo verde, cat's claw, and hackberry in California, Arizona, New Mexico, and Texas. *C. dentipes* (Germ.) is 10–16 mm. long, brown or black, and faintly shiny. The larvæ mine the dead limbs and trunks of yellow pine in British Columbia, Washington, Oregon, California, Nevada, Arizona, and New Mexico. *C. exesa* Lec. is 9–13 mm. in length, dark bronze, the punctured spaces coppery. It mines the bark, sapwood, and heartwood of mesquite in Southern California, Arizona, New Mexico, and Mexico. *C. falli* Van Dyke is 11 mm. long, black or greenish, with punctate areas coppery. It breeds in Jeffrey and yellow pine in the Sierras of California.

The flat-headed apple tree borer, *Chrysobothris femorata* Olivier, is a common orchard pest throughout North America. The adults are 7–16 mm. in length, greenish blue or brassy, with the punctured spaces coppery. The very flat, somewhat circular yellowish eggs 0.5 mm. in diameter are laid in the crevices of the bark. The mature larvæ are pale yellow and 25 mm. long. The winter is spent in the mature larval stage in a prepupal cell in the heartwood where pupation occurs in the spring. The adults fly from March through September. They lay eggs on hot days and will usually oviposit only in the sunshine. The larvæ mine the inner bark, cambium, sapwood, and heartwood of normal, injured, dying or dead wood of very many deciduous fruit, shade, and native trees and shrubs including apple, apricot, ash, mountain ash, beech, box elder, cherry, chestnut, cottonwood, currant, elm, hickory, horse-chestnut, linden, maple, oak, peach, pear, pecan, plum, poplar, prune, raspberry, rose, sycamore, and willow, with oak as the preferred host. In California the species is chiefly a pest to forest trees and is largely replaced in the orchards by *C. mali* Horn, according to H. E. Burke. It occurs throughout North America and is recorded from every Western State. It chiefly attacks injured trees and particularly those sunburned or in need of irrigation during the summer and fall months. Thorough irrigation and the use of good white tree-protectors to cover the trunks of small trees give very good control.

[1] Geo. H. Horn, "Mon. of *Chrysobothris* of U. S." *Trans. Am. Ent. Soc.*, 13, p. 65, 1886. H. C. Fall, *Jour. N. Y. Ent. Soc.*, 18, p. 45, 1910.

The western flat-headed apple tree borer, *Chrysobothris mali* Horn (Fig. 277), is 6–11 mm. long, dark bronze reddish copper, with more or less distinct coppery spots on the elytra. It is separated from the preceding by the presence of a short lobe on the front margin of the prosternum and by the absence of a pronotal sulcus. The mature larvæ average 13 mm. They mine normal, injured, dying, and dead trees and shrubs, and prefer living limbs exposed to the sun rather than dead ones. The larvæ hibernate in a prepupal cell in hardwood and pupate from March through June. The adults fly from April through August. Ceanothus is the preferred host but the species also seriously infests alder, apple, apricot, ash, mountain ash, beech, blackberry, box elder, California Christmas berry, California coffee berry, cherry, Catalina cherry, currant, elm, eucalyptus, gooseberry, loquat, manzanita, maple, mesquite, mountain mahogany, oak, peach, pear, plum, poplar, prune, rose, sycamore, and willow. Control measures are the same as for the preceding species.

FIG. 277.—The western flat-headed apple tree borer, *Chrysobothris mali* Horn. Larva, adult and work of larvæ beneath the bark of a prune tree. The dead outside bark has been removed.

Chrysobothris bacchari Van Dyke is similar in size and form but more brassy and greenish. It infests living, injured, and dead chapparal broom in California and Arizona. *C. gemmata* Lec. is 19–22 mm., purple or violet above and bright green beneath. It mines the bark, sapwood, and heartwood of living, dying, and dead limbs and trunks of mesquite, and severely injures the wood and often entirely kills the trees in Arizona. *C. laricis* Van Dyke is 11 mm. long, nearly black, with coppery punctures much like *C. femorata* Olivier. The venter is metallic green. It breeds in western larch, Douglas fir, white pine, lodgepole pine, and yellow pine in Oregon and California. *C. ludificata* Horn is 10–12 mm. long, black or nearly so, with cupreous punctures. The larvæ mine the bark and sapwood of dying and dead limbs, logs, and stumps of yellow pine, and are common in the slash in Arizona. The species also occurs in New Mexico, Colorado, and California. *C. merkeli* Horn is 15–17 mm. in length, robust black or faintly bronzed and cupreous beneath. It mines dying and dead mesquite and cat's claw in California, Arizona, New Mexico, and Texas. *C. nixa* Horn is 8–10 mm. and of a dark sub-opaque

coppery color. It mines the inner bark and wood of normal, injured, and dead incense cedar, juniper, and Monterey cypress, and kills many young trees and saplings. It is common in felled incense cedar. The adults fly from March through August. The species occurs in California and Nevada. *C. octocola* Lec. is 10–15 mm. long, dark olive bronze and faintly reddish. It mines the bark and wood of injured and dead mesquite and palo verde and completely destroys wood and fence posts in Southern California, Arizona, Texas, and Mexico. To prevent injury, wood and posts should be cut between the middle of October to the last of January and piled in loose ricks to insure rapid curing. *C. pseudotsugæ* Van Dyke is 11 mm. long, somewhat cupreous, the elytral punctured spaces greenish bronze, the venter and legs brilliant green. It mines Douglas fir, white fir, and grand fir in California. *C. purpurifrons* Mots. (*C. contigua* Lec.) is 7–11 mm. in length and dark bronze. It breeds in small limbs of yellow pine and nearly dead limbs of apple and live oak. The range is California, Nevada, Oregon, Washington, and British Columbia. *C. sylvania* Fall is 11.5–12 mm. long, dusky, with the ventral surface of a bright green or bronze color. The larvæ are white, 24–27 mm. long, and mine the bark, cambium, and wood of Douglas fir and fruit trees. Pupation occurs in March and April and the adults fly in April and May. The range is in California and Oregon. *C. trinervia* (Kirby) is black with brassy lustre. The larvæ mine the bark and sapwood of normal, dying, and dead limbs and trees of limber pine and yellow pine, and often kill young saplings of the latter. It ranges from Alaska into British Columbia, Utah, Colorado, New Mexico, and the east. *C. viridicyanea* Horn is 8–9 mm. in length, iridescent bright cobalt blue and green. It mines incense cedar and juniper in California, Nevada, and Montana.

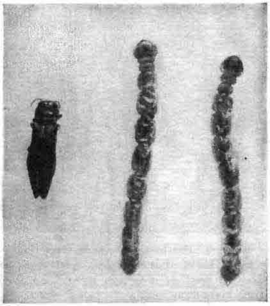

FIG. 278.—The oak twig girdler, *Agrilus angelicus* Horn. Adult and larva.

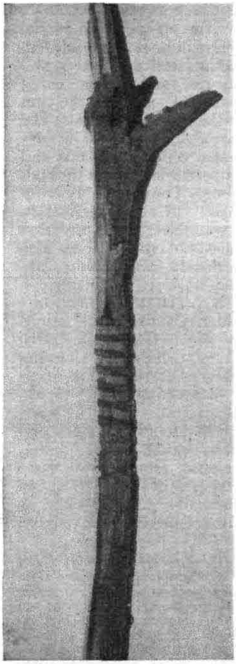

FIG. 279.—Work of the oak twig girdler, *Agrilus angelicus* Horn, on twig of coast live oak. The bark has been removed to show the spiral burrow.

The genus *Agrilus* [1] is composed of small, slender, elongate beetles having the prosternum pointed behind, and the head, thorax, and elytra of about the same width. **The oak twig girdler,** *Agrilus angelicus* Horn [2] (Figs. 278, 279), is 6.5 mm. long, and moderately shining brassy. The adults fly from May through July and feed on the foliage. The eggs are laid singly on the bark of twigs which are completely girdled spirally under the bark by the larvæ which are white and 25 mm. long. The life cycle requires 2 years. This species is quite destructive to ornamental trees, producing numerous dead twigs throughout the top, and attacks oaks including the coast live oak, interior live oak, Engelmann oak, Wislizenus oak, tanbark oak, and introduced species in California. Many natural enemies [3] are listed. Cutting and burning the infested twigs give some control on ornamental trees when not too close to large stands of oak. *Agrilus politus* (Say) has often been confused with the above species which it very much resembles. The adults fly from May through August, feed on the foliage of the host plants, and lay the eggs in series of from 1–2 on the smooth bark of the branches and trunks. The larvæ girdle and kill small twigs and entire trees. The life cycle requires one year in California and two years in Montana. The hosts are alder, buckeye, hazelnut, maple, and willow, and the distribution includes Oregon, Nevada, Colorado, Arizona, New Mexico, and the east. *A. burkei* Fisher is closely related to and often confused with the preceding. The larvæ mine the inner bark and wood of normal injured, and dying white and mountain or paperleaf alder in California. **The bronze birch borer,** *Agrilus anxius* Gory, is 7–12 mm. long, bronzy brown. The larvæ mine the inner bark of normal, dying, and dead aspen and ornamental birch trees, girdling and killing the branches and entire trees. It is a common eastern species ranging west into Colorado and Idaho. **The two-lined chestnut borer,** *Agrilus bilineatus* (Weber), is 5.5 to 9.5 mm. in length, black with greenish lustre, and partly clothed with yellow pubescence. It is a common eastern species ranging west to the Rocky Mountains and girdles and kills oak trees in Colorado. *A. nevadensis* Horn is 10 mm. long, black, with violet lustre beneath. The larvæ mine and kill the tops of poplars in California and Nevada. *A. granulatus* (Say) girdles and kills limbs and entire poplar and cottonwood trees. It is eastern, ranging west into Colorado, Wyoming, and Montana. *A. niveiventris* Horn mines the inner bark and wood of normal, dying and dead Lombardy poplar in California and Arizona. Many trees are completely girdled and killed by it. The willow is the normal host.

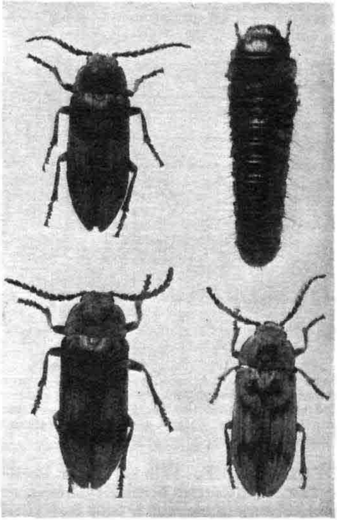

FIG. 280.—Davidson's beetle, *Dascillus davidsoni* Lec. Adults and larva.

[1] Geo. H. Horn, "The Spp. of *Agrilus* of Boreal America." *Trans. Am. Ent. Soc.*, 18, p. 277, 1891.
[2] H. E. Burke, *Jour. Econ. Ent.*, 10, p. 330, 1917; 13, p. 379, 1920.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed., p. 234, 1915.
[3] S. A. Rohwer, *Proc. Ent. Soc. Wash.*, 21, 1919, p. 4.

DASCILLIDÆ. Soft-bodied Plant Beetles.

Davidson's beetle, *Dascillus davidsoni* Lec. (Fig. 280), is 10–40 mm. long, rich shiny brown or blackish, covered with gray pruinose arranged on the elytra so as to expose two irregular bare, brown crossbands. The larvæ are yellowish, entirely covered with long fine brownish hairs, and somewhat resemble white grubs, but are larger anteriorly, tapering posteriorly and more flattened. The writer has taken them in the soil apparently feeding on roots of snowberry and other native plants, and on acacia and apple. They are also reported among the roots of cherry. The adults appear early in the spring and feed on apricot and other fruit trees in California. *D. plumbeus* Horn, is 20 mm. long, entirely black, and covered with gray pubescence giving a slaty color. The adults often feed on fruit trees in California.

The aquatic dascillid, *Eubrianax edwardsi* (Lec.) (*Placonycha*) (Fig. 281), is black with brownish legs. The males have pectinate antennæ, luteous elytra, and are 3.5 mm. long, while the females have nonpectinate antennæ, black elytra, and are 5 mm.

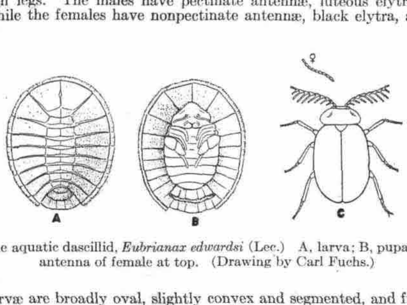

FIG. 281.—The aquatic dascillid, *Eubrianax edwardsi* (Lec.) A, larva; B, pupa; C, adult male, antenna of female at top. (Drawing by Carl Fuchs.)

long. The larvæ are broadly oval, slightly convex and segmented, and fringed as illustrated. They live on rocks in small, fresh running streams along the coast of California and are common in the San Francisco Bay region. Pupation occurs in the old larval skin in the water. There is some doubt about the exact generic position of this interesting species.

DERMESTIDÆ. Skin or Larder Beetles.

The Buffalo carpet beetle, *Anthrenus scrophulariæ* (Linn.) (Fig. 282), is probably the most widely and best known member of this family, being cosmopolitan in distribution. The adults are oval, convex, 3 mm. long, black, covered with white, brown, and yellowish scales so as to be decidedly mottled in appearance. The eggs are white and usually laid on the food. The larvæ are yellowish brown, clothed with long brown hairs. They feed on woolen fabrics, dried insects and other museum specimens, feathers, horn, hair, and other dried animal products. The adults frequently occur on the windows of buildings housing infested articles, but in nature they are often abundant on flowers such as wild carrot or parsnip, ceanothus, wild buckwheat, and so forth. A weak solution of lysol, 1 pint to 5 gallons of water, applied as a very fine spray affords a ready cure and sure preventive. The odor evaporates in about 12 hours. *A. verbasci* (Linn.) (*A.*

varius Fabr.) is 2–3 mm. long, of much the same color, but largely black on the median parts of the pronotum and the elytra, with a zigzag pattern of light scales. The adults are common on certain flowers and the larvæ have habits similar to the preceding. They are particularly fond of horn and whalebone. It is a cosmopolitan species. **The black carpet beetle,** *Attagenus piceus* Olivier, is 1.52 mm. long and dark brown or black. It

FIG. 282.—The Buffalo carpet beetle, *Anthrenus scrophulariæ* (Linn.). Typical colony in dead bee brood. A, adults; B, eggs; C, larvæ; D, pupæ; E, cast pupal skins.

has habits similar to the preceding species and is widely distributed, having been recorded from Colorado, New Mexico, Idaho, in the west and Hawaii.

The larder beetle, *Dermestes lardarius* Linn., is 6–7.5 mm. in length, black, the bases of the elytra marked with white, and the legs and under surface clothed with fine yellowish pubescence. It is a common pest on ham, bacon, and other cured meats and animal products. It is found throughout the world. **The common carrion dermestid,** *Dermestes marmoratus* Say, is 7–11 mm. long, black, with a more or less broad broken band of white scales on the bases of the elytra, and numerous white spots on the dorsum. The venter is largely white. It is a cosmopolitan species feeding on carrion and dry animal products and was distributed throughout California by hide and tallow traders in early days. It now occurs in many Western States. **The hide and tallow dermestid,** *D. vulpinus* Fabr., is 5–8 mm. long, black above and largely white beneath. It feeds on carrion, hides, tallow, and other animal matter, and was carried to California by the early traders. It ranges north into Alaska and Siberia and has a cosmopolitan distribution. *D. talpinus* Mann. is 5.5–6.5 mm. in length, black, the thorax clothed with variegated hairs, and the elytra with gray or yellowish hairs. It is probably western and occurs in California, Nevada, Idaho, British Columbia, and New Mexico. *Perimegatoma variegata* Horn (Figs. 283, 284) is 4.7 mm. long, oblong, oval, brown with a distinct basal and an apical white zigzag transverse band on the elytra. The larvæ are brown with the integument between the segment appearing as yellow rings,

and with a tuft of fine brown hair on the head and a long tail-like tuft behind. The larvæ feed as scavengers in the cocoons of the tussock moth, tent caterpillars, codling moth, and other moths in California. They are also supposed to destroy the eggs of the tussock moth. *Trogoderma ornata* Say, *T. sternalis* Jayne, and *T. tarsalis* Melsh. are small beetles which feed on cereals, seeds, drugs, nuts, insect and plant museum

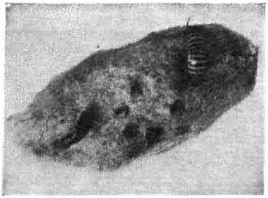

FIG. 283.—Larvæ of *Perimegatoma variegata* Horn on cocoon of the California tussock moth.

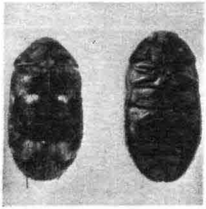

FIG. 284.—*Perimegatoma variegata* Horn. Adults.

specimens, and other dry animal and vegetable matter. The first two are widely distributed throughout the country, and the last occurs in Mexico, Texas, New Mexico, Arizona, and Southern California.

BYRRHIDÆ. Pill Beetles.

The pasture pill beetle, *Amphicyrta dentipes* Er., is a robust, shining brown or black beetle, 9 mm. long. The larvæ are shining black or brown and 10 mm. long. They live in holes in the ground, emerging to the surface to feed on wild grasses, clovers, oats, and weeds. An infestation was observed in pasture lands of San Benito County, California, April 27, 1922, where the larvæ denuded a small area. They were also observed taking grass into their holes in Monterey County the same season. The adults were found resting on the plants, but did no apparent damage. This beetle is fairly common in California.

CLAVICORNIA (Series IV)

KEY TO FAMILIES

1. Tarsi 3-jointed.. 2
   Tarsi 4-jointed.. 3
   Tarsi 5-jointed.. 4
   Tarsi heteromerous (first and second pairs 5-jointed and hind pair 4-jointed); head narrower than the thorax; antennæ bead-like usually 11-jointed; mandibles with basal tooth; eyes usually transverse; tarsal claws simple. Small to large smooth or hairy brown or black beetles. (Darkling Ground Beetles.).. **Tenebrionidæ** p. 427

2. Head deeply joined into the prothorax; elytra entire; front and hind coxæ transverse, middle coxæ globular; tarsi dilated; claws dilated or toothed at base. Small oval predaceous beetles. (Ladybird Beetles.)........ **Coccinellidæ** p. 412
   Head not immersed into prothorax; elytra often truncate; all coxæ transverse; tarsi not dilated; claws simple. Small oval or somewhat flattened beetles. (Sap-feeding Beetles.)............................ **Nitidulidæ** (in part) p. 408

3.[1]First 3 or 4 ventral abdominal segments fused; antennæ 10- to 11- or rarely 8-jointed, terminating in a 1- or 2-jointed club; front and middle coxæ small and globular, hind coxæ transverse. Small elongate or cylindrical bark or ground beetles. (Cylindrical Barkbeetles.) .... **Colydiidæ** p. 412
All ventral abdominal segments free and movable; antennæ 8- to 11-jointed, the last 3 joints forming a loose club; first abdominal segment longest; last tarsal joint longest; claws simple. Minute sub-cylindrical black or brown beetles found under bark and in fungi. (Minute Tree-Fungus Beetles.) (*Coidæ*) **Cisidæ**

4. Claws with a large basal tooth; tarsal joints 2 and 3 lobed beneath; front coxæ closed behind; antennæ 11-jointed, the last three joints forming a club. Small convex oval beetles found in flowers. (Byturid Beetles.) .... **Byturidæ**
Claws simple 5

5. Front coxæ transverse 6
Front coxæ not transverse 7

6. Tarsi more or less dilated, first joint not shortened; fourth joint very small; elytra truncate, not usually extending to the tip of the abdomen. (Sap-Feeding Beetles.) .... **Nitidulidæ** (in part) p. 408
Tarsi slender, the first joint very small; elytra never truncate, always covering abdomen. Small to medium, usually flattened beetles living under bark or inhabiting granaries. (Grain and Bark-Gnawing Beetles) ....
(*Trogositidæ*) **Ostomidæ** p. 408

7. Front coxæ globose, closed behind; tarsi dilated and hairy, fourth joint very small; antennæ 11-jointed, the last 3 or 4 joints forming a club; elytra entire; head immersed into the thorax almost to the eyes. Small to medium red and black beetles. (Pleasing Fungus Beetles.) .... **Erotylidæ**, p. 410
Front coxæ oval 8

8. Antennæ filiform or terminating in a more or less distinct club or knob 9
Antennæ terminating in a number of tooth-like or serrate joints 10

9. Middle coxal cavities not closed on the outer side by the union of the meso- and metasterna; tibiæ with 2 spurs; antennæ 11-jointed; elytra covering abdomen. Small very flat black, brown or reddish beetles often living under bark. (Flat Barkbeetles.) .... **Cucujidæ** p. 409
Middle coxal cavities closed by the sterna; prosternum prolonged; front coxal cavities open behind; antennæ 11-jointed with loose club. Very small oval or elongate, flat, pubescent, punctate and often yellow or brown beetles. (Silken Fungus Beetles.) .... **Cryptophagidæ** p. 410

10. First tarsal joint longer than the second 11
First tarsal joint shorter than the second 12

11. Antennæ inserted on the front of the head close together at the base; thorax without lateral margin; head retractile, front and middle coxæ cylindrical, hind coxæ transverse. Small to medium-sized elongated, robust brown or blackish beetles (Ptinid Beetles, Spider Beetles) .... **Ptinidæ** p. 433
Antennæ inserted on the sides of the head in front of the eyes and usually distant at the base; thorax usually with lateral margins. Small brown or black, elongated and depressed beetles. (Death Watch Beetles) ...... **Anobiidæ**, p. 433

12. First abdominal segment longer than the others; antennæ terminating in 2 saw-tooth joints; head prominent, free. Elongated slender black or brown beetles. (Powder Post Beetles) .... **Lyctidæ** p. 438
First abdominal segment equal in length to the others; antennæ terminating in 3 or 4 saw-toothed joints; head deflexed and often hidden by prothorax. Usually robust or cylindrical brown or black beetles. (Branch and Twig Borers.) .... **Bostrichidæ** p. 434

[1] The males of some of the *Cucujidæ* and *Cryptophagidæ* and a few of the *Nitidulidæ* also have 4-jointed tarsi.

OSTOMIDÆ (*TEMNOCHILIDÆ, TROGOSITIDÆ*). Grain and Bark-Gnawing Beetles.

The green trogositid, *Temnochila virescens* (Fabr.) (*Trogosita*) (Fig. 285), is a common western representative of this family. The adults are 10-13 mm. long, elongate, flattened, entirely metallic green or blue. The larvæ are white with shiny black head and prothoracic shield. The adults and larvæ are predaceous on the wood-boring and barkbeetles, the adults often occurring in the outer bark and the larvæ in the burrows. This species occurs in New Mexico, Arizona, California, and along the Pacific Coast into British Columbia. *Corticotomus californicus* Van Dyke is 3 mm. long, narrow, slightly shining, and rufous. It lives in the dead limbs of yellow

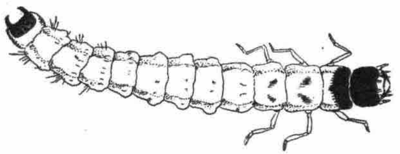

FIG. 285.—Larva of the green trogositid, *Temnochila virescens* (Fabr.).

pine in California. *C. caviceps* (Fall) has distinct elytral striæ the full length. It occurs in yellow pine in New Mexico, Colorado, Arizona, and California. *Nemozoma attenuatum* Van Dyke (*Nemosoma*) is 4 mm. long, shining black with blue lustre. It occurs in dead Monterey pine in the native forests of California.

The cadelle, *Tenebroides mauritanicus* (Linn.), is a cosmopolitan representative of the family having been carried to all parts of the world by trade. The beetles are 7–10 mm. long, shining black, and much flattened. The larvæ are 12 mm. long, pinkish, white, or yellow, with dark brown or black head, and two horn-like anal appendages. All stages are commonly found in cereals and cereal products in flour and grain mills, granaries, warehouses, feed and grocery stores, where the larvæ feed upon such materials as well as on shelled peanuts and walnuts.

NITIDULIDÆ. Sap-Feeding and Dried Fruit Beetles.

The dried fruit beetle, *Carpophilus hemipterus* (Linn.)[1] (Fig. 286), is 4 mm., short, flattened, black, with a pair of pale brown spots on the elytra, pale antennæ and legs, and the two posterior abdominal segments exposed by the short truncate elytra. The larvæ are yellowish, 6 mm. long, clothed with a few long hairs, and with two large brown tubercles at the extreme posterior end and two smaller ones just in front of the larger. The adults are specially attracted to broken, fermenting, and dried fruits, and are common in the orchards, drying sheds, on the fruit trays, and in packing houses wherever fresh or dried fruits are found. The species is probably instrumental in carrying fig smut. The larvæ freely breed in and often seriously injure dried fruits of all kinds. Cleanliness in the orchards and about dry yards, canneries, and packing houses should be practiced to

[1] E. O. Essig, *Jour. Econ. Ent.*, 8, p. 396, 1915.

eliminate breeding places. It is a cosmopolitan species common and abundant in the west from New Mexico and Southern California to Alaska. *C. dimidiatus* (Fabr.) is 2–3.5 mm. long, dark to reddish brown, with the thorax nearly square. It is also a cosmopolitan species taken by the writer

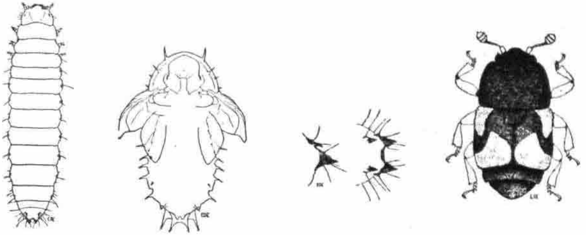

FIG. 286.—The dried fruit beetle, *Carpophilus hemipterus* (Linn.). Larva, pupa, posterior tip of larva, and the adult.

in decaying oranges and shelled peanuts, and reported in ripening dates in Arizona by A. W. Morrill, and also infests corn meal. *C. niger* (Say) is about the same size as the preceding species, black, with the elytra partly rufous. It has been taken in fermenting dried figs and other fruits and from the fermenting sap of trees, and occurs in every Western State and throughout North America. *C. pallipennis* (Say) is 3–4 mm. long, varying from amber to reddish brown, often with head and thorax darker than the elytra. It is common in the flowers of cacti in Southern California, Arizona, New Mexico, Colorado, Texas, and Mexico. It has also been found in stored corn. **The fruit bud beetle,** *Conotelus mexicanus* Murray,[1] is 3 mm. long, and black. It appears in March and attacks the opening buds of blackberries, peaches, roses, and the flowers of blackberries, cotton, oranges, lemons, and so on, often doing considerable damage. It ranges from Mexico into Arizona and California.

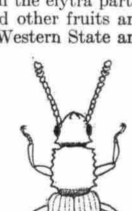

FIG. 287.—The saw-toothed grain beetle, *Oryzæphilus surinamesis* (Linn.).

CUCUJIDÆ. Flat Barkbeetles.

The saw-toothed grain beetle, *Oryzæphilus surinamesis* (Linn.) (*Silvanus*) (Fig. 287), is the most widely distributed and best known member, having been carried by commerce to all parts of the world. The adults are 3 mm. long, very small, pale or dark brown, slender, flat, each of the lateral margins of the prothorax having a series of six saw-teeth. The species breeds in all cereals and cereal products, dried fruits, nuts, various seeds and seed meals, yeast cakes, and so forth, and is a serious pest in granaries, store-houses, mills, grocery stores, ships, and residences. Out-of-doors the adults frequently

[1] A. W. Morrill, *Eighth Ann. Rept.*, Ariz. Com. Agr. & Hort., p. 33, 1916

occur under the bark of trees. The beetle can be killed by fumigating and by heating up to 46° C. to 48° C.[1] *O. mercator* (Fauvel) and *O. bicornis* (Er.) also occur in similar products in our region, having been recorded in Southern California and Arizona. **The foreign grain beetle,** *Cathartus advena* (Waltl.), and **the square-necked or red grain beetle,** *C. gemellatus* Duv., are small reddish brown beetles infesting cereals and cereal products throughout the country. **The flat grain beetle,** *Læmophlæus pusillus* (Schön.), is a tiny flat, reddish brown beetle 2.5 mm. long, and is a cosmopolitan species breeding in cereals, cereal products, and dried fruits. It has been taken in dried dates and shelled peanuts in California, and has been reported also in Montana and Alaska in the west.

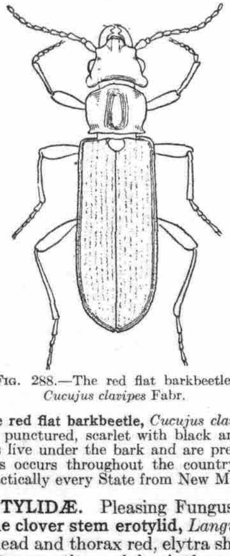

FIG. 288.—The red flat barkbeetle, *Cucujus clavipes* Fabr.

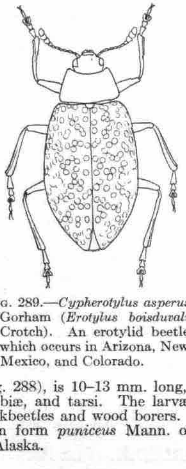

FIG. 289.—*Cypherotylus asperus* Gorham (*Erotylus boisduvali* Crotch). An erotylid beetle which occurs in Arizona, New Mexico, and Colorado.

The red flat barkbeetle, *Cucujus clavipes* Fabr. (Fig. 288), is 10–13 mm. long, very finely punctured, scarlet with black antennæ, eyes, tibiæ, and tarsi. The larvæ and adults live under the bark and are predaceous on barkbeetles and wood borers. The species occurs throughout the country. The western form *puniceus* Mann. occurs in practically every State from New Mexico north to Alaska.

EROTYLIDÆ. Pleasing Fungus Beetles.

The clover stem erotylid, *Languria mozardi* Latr., is 5.5–8 mm., slender, the head and thorax red, elytra shining dark blue, venter red, the antennæ, last two or three abdominal segments, tarsi, and apical half of femora black. The larvæ bore the stems of wild lettuce, clover, and alfalfa. It is a middlewest insect which is at times a pest to alfalfa in Arizona.[2]

CRYPTOPHAGIDÆ. Silken Fungus Beetles.

Cryptophagus acutangulus Gyll. is 2.3 mm. long and pale yellowish. It is a cosmopolitan species taken in cereals and sacked sugar in California. *C. lepidus* Casey

[1] W. H. Goodwin, *Jour. Econ. Ent.*, 7. p. 316, 1914.

[2] A. W. Morrill, *Seventh Ann. Rept.*, Ariz. Com. Agr. and Hort., p. 38, 1915.

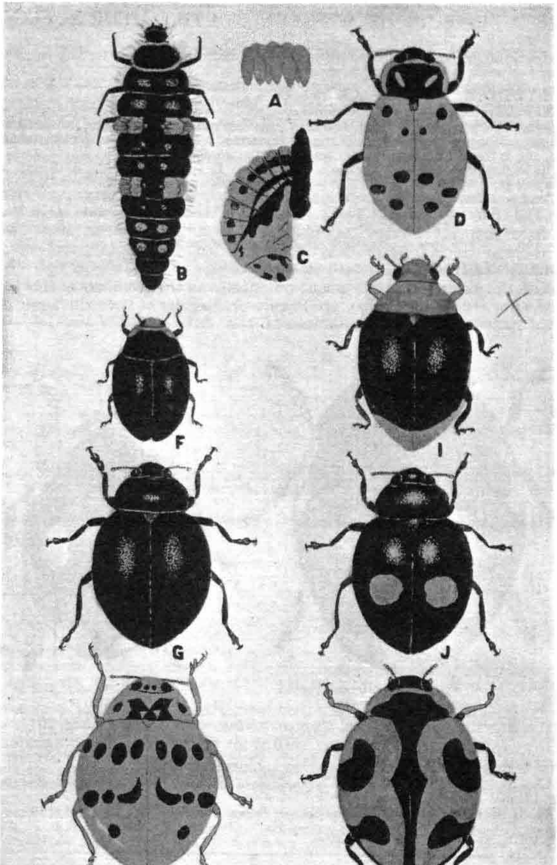

FIG. 290.—Some important western ladybird beetles. A, eggs; B, larva; C, pupa; D, adult of the convergent ladybird, *Hippodamia convergens* Guérin; F, the margined scymnid, *Scymnus marginicollis* Mann.; G, the black ladybird, *Rhizobius ventralis* (Er.); H, the ashy gray ladybird, *Olla abdominalis* (Say); I, the mealybug destroyer, *Cryptolæmus montrouzieri* Muls.; J, the two-stabbed ladybird, *Chilocorus bivulnerus* Muls.; K, the vedalia, *Rodolia cardinalis* (Muls.).

is a beetle of similar appearance, with whitish larvæ. It was found feeding on kernels of apricot seeds in storage in California.

COLYDIIDÆ. Cylindrical Barkbeetles.

The mushroom beetle, *Aglenus brunneus* (Gyll.), is a very small, slender, brown, cosmopolitan beetle, 2–3 mm. long, taken in countless numbers destroying mushrooms in commercial beds in Southern California. It normally feeds in sod or decayed vegetation, and is frequently found under boards on the ground.

The buprestid destroyer, *Deretaphrus oregonensis* Horn, is 11.5 mm. in length. It is an elongate, black beetle which lives in the burrows and destroys the larvæ and pupæ of *Dendroctonus jeffreyi* Hopk., *D. monticolæ* Hopk., *Trachykele opulenta* Fall, *T. nimbosa* Fall, *Buprestis aurulenta* Linn., *B. læviventris* (Lec.), and *Asemum atrum* Esch., in California and Oregon.[1] The larvæ are whitish, with small head, well developed legs, and recurved hooks. Pupation occurs in a brownish cocoon.

COCCINELLIDÆ.[2] Ladybird Beetles.

With the exception of one genus, practically all the members of this large family are beneficial, as they are largely predaceous in both the adult and larval stages on aphis and scale insects.

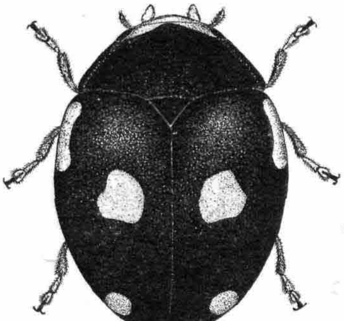

FIG. 291.—The lateral ladybird beetle, *Hyperaspis lateralis* Muls.

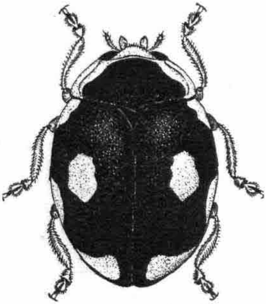

FIG. 292.—*Hyperaspis undulata* (Say).

The lateral ladybird beetle, *Hyperaspis lateralis* Mulsant (Fig. 291), is 3 mm. in diameter, shining black, with front of the head, front margins of

[1] H. E. Burke, *Proc. Ent. Soc. Wash.*, 19, pp. 123, 124, 1917.

[2] Geo. R. Crotch, "Revision of *Coccinellidæ* of U. S." *Trans. Am. Ent. Soc.*, 4, p. 363, 1873.

Geo. H. Horn, "Studies in *Coccinellidæ*." *Trans. Am. Ent. Soc.*, 22, p. 81, 1895.

Thos. L. Casey, "Rev. of Am. *Coccinellidæ*." *Jour. N. Y. Ent. Soc.*, 7, p. 71, 1899.

C. W. Leng, "Notes on *Coccinellidæ*." *Jour. N. Y. Ent. Soc.*, 11, pp. 35, 193, 1903; 16, p. 33, 1908.

E. O. Essig, "Larval Characters—After G. W. Dimmock." *P. C. Jour. Ent.*, 2, p. 260, 1910.

M. Palmer, "Notes on Life History of Ladybird Beetles." *Ann. Ent. Soc. Am.*, 7, p. 213, 1914.

A. Böving, "Generic synopsis of Larvæ of *Coccinellidæ*." *Proc. U. S. Nat. Mus.*, 51, p. 621, 1917.

T. H. Gage, "Larvæ of *Coccinellidæ*." *Ill. Biol. Mon.*, 6, No. 4, 1920.

the prothorax, the front margins of the elytra, and a pair of median and a pair of apical spots yellow, orange, or red. The larvæ are entirely covered with long white wax. The species is very common and an effective predator on various mealybugs and particularly on the redwood mealybug, *Pseudococcus sequoiæ* (Coleman), on Monterey cypress. Its effectiveness is lessened by a parasite, *Homalotylus* sp., which often issues in great numbers from the pupæ. The distribution includes Mexico, New Mexico, Arizona, Colorado, and Montana. *H. undulata* (Say) (Fig. 292) is 2–2.5 mm. long, black, the face and sides of the prothorax yellow in the male and black in the female, and three pairs of marginal and one pair of dorsal yellow spots on the elytra. The species feeds on various unarmored scales and is a common predator of *Toumeyella mirabilis* Ckll. on mesquite in Arizona. The species occurs throughout much of the United States and is known in New Mexico, Arizona, Utah, and Southern California.

Microweisea misella (Lec.) is 0.8–1.0 mm. long, and black. It is a common and often efficient predator on San José scale in New Mexico, Arizona, California, and Oregon. It normally ranges in the east. *M. suturalis* Schwarz is 0.8 to 0.9 mm. long, shining black, the elytra brownish red with suture narrowly black. The larvæ are 1.5 mm. long, olive brown to salmon, with the head and legs black. The pupæ are pale yellow to orange red. This species feeds on the red scale, San José scale, and red spiders in Southern California.

The red spider destroyers, *Stethorus picipes* Casey (Fig. 293), 1.0–1.3 mm., *S. punctum* (Lec.), 1–1.2 mm., and *S. vagans* (Blackb.), 0.8–1 mm., are all minute black species with the surface very finely punctured and covered with minute hairs. The eggs are yellow, pinkish, or gray, and are laid singly on the leaves. The very small larvæ, 1 or 1.5 mm. long, are dark with short spines. The larvæ and adults prey chiefly on various species of red spiders. The first and last occur in California, while the second is widely distributed in the west and North America.

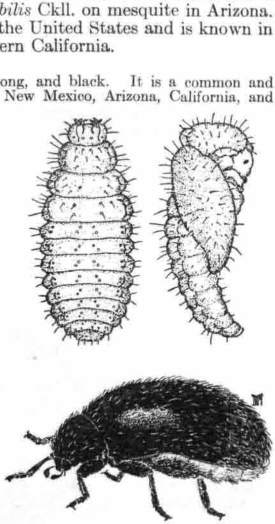

FIG. 293.—The red spider destroyer, *Stethorus pictipes* Casey. Larva, pupa and adult. (After Quayle.)

The genus *Scymnus* includes a great many species of small black, brown, mottled, or spotted beetles, the larvæ of which are usually covered with a white wax and are often mistaken for mealybugs. They feed on mealybugs, other scale insects, aphis, red spiders, mites, and other small animals. *Scymnus guttulatus* Lec.[1] (Fig. 294) is 1.5–2 mm. long, black, with one or two fused spots and a brownish band on each elytron. It occurs in California and is often abundant feeding on mealybugs. **The margined scymnid,** *Scymnus marginicollis* Mann. (Fig. 290, F), is 1.6–2 mm. long, black, and the front margin or portion of the pronotum cinnamon red. It is a very common and beneficial species in New Mexico, Arizona, and California, and preys on red spiders and armored scales. **The cloudy scymnid,** *Scymnus nebulosus* Lec. (Fig. 295), is 2–2.25 mm. long, pale brown, the elytra with darker markings, the abdomen black, and the legs reddish. It preys on red spiders, mealybugs, and aphis in Colorado and California. *S. nubes* Casey is 1.8–2 mm. in length, reddish, the

[1] E. O. Essig, Life History. *P. C. Jour. Ent.*, 3, p. 395, 1911.

pronotum with a large black spot, the elytra black, each with a short narrow longitudinal and slightly oblique median vitta, legs dus y. The larvæ are 4.2 mm. long, yellow, and covered with long white woolly wax. They feed on nearly all species of aphis in Arizona and Southern California. *S. sordidus* Horn is 1.5–2 mm. long and varies from pale brown to blackish. It feeds on mealybugs, other scale insects, and aphis in New Mexico, Arizona, and California. *S. bipunctatus* Kugelann[1] (Fig. 296), is 1.5–2 mm.

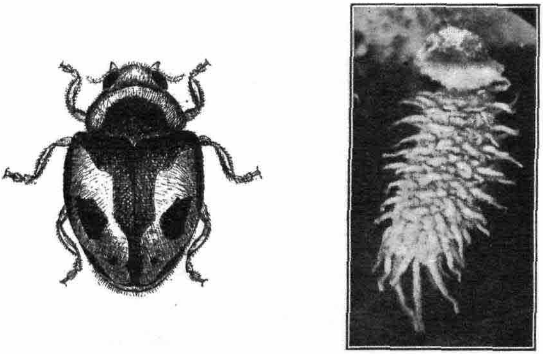

FIG. 294.—*Scymnus guttulatus* Lec. Adult and larva. (Larva after H. S. Smith.)

FIG. 295.—The clouded ladybird beetle, *Scymnus nebulosus* Lec. (After Quayle.)

FIG. 296.—The two-spotted scymnid, *Scymnus bipunctatus* Kugel. Adult, larva, and citrus mealybugs. (Larva after H. S. Smith.)

long, black, with a pair of large oval, orange or brown spots on the elytra. It was introduced into California from the Philippine Islands in 1910 and again in 1914 and is established in the citrus orchards of Southern California where it feeds on mealybugs. *S. binævatus* Mulsant is 1 mm. long, black, with two reddish spots near the posterior end of the elytra. It was introduced from South Africa in 1921 by the State Insectary to feed on mealybugs, and is now well established in many parts of California.

[1] This species was formerly wrongly supposed to be *Aspidimerus (Cryptogonus) orbiculus* (Gyll.), a Japanese species. E. O. Essig, *P. C. Jour. Ent.*, 3, 390, 1911.

The mealybug destroyer, *Cryptolæmus montrouzieri* Mulsant [1] (Figs. 290, I; 297), is 3-3.5 mm. long, shining black, with the head, prothorax, tips of the elytra, and abdomen reddish. The minute oval eggs are yellow and are laid singly among the hosts. The larvæ are yellow and entirely covered with long white waxy filaments. When mature they are 7-10 mm. long and are often mistaken for huge mealybugs. The species was introduced from Australia into California in 1892 by Albert Koebele

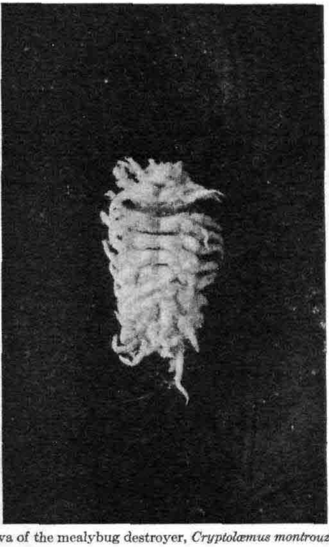

FIG. 297.—Larva of the mealybug destroyer, *Cryptolæmus montrouzieri* Mulsant.

and has proven to be one of the most proficient enemies of the many kinds of mealybugs in California where it is firmly established. It is also propagated artificially to be liberated on plants infested with mealybugs and other scale soft insects.

The vedalia, *Rodolia cardinalis* (Mulsant) (*Vedalia, Novius*) [2] (Figs. 290, K; 298, 299), is the most famous ladybird beetle in California and was the first successful introduction of a beneficial insect into any country to prey upon an injurious one, and is therefore the standard example and one of

[1] E. O. Essig, Life History. *P. C. Jour. Ent.*, 2, p. 363, 1910.
H. S. Smith and H. M. Armitage. *Mthly. Bul.*, Cal. State Dept. Agr. 9, p. 114, 1920.
[2] D. W. Coquillett, *Insect Life*, 2, p. 70, 1888.

the most striking cases of biological control. It was introduced into Southern California from Australia in 1888 and 1889. The small adults are nearly hemispherical, 2.5–3.5 mm. long, red, with irregular black markings on the dorsum. In the females red predominates, while the males are more black. Fine body hairs often greatly obscure the color pattern

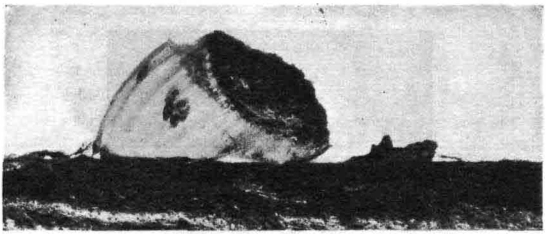

Fig. 298.—Eggs of the vedalia, *Rodolia cardinalis* (Mulsant), on egg sac of the cottony cushion scale.

and give a decidedly gray appearance. The tiny oblong, bright red eggs are laid singly or in small masses on the egg sac of the host, the cottony cushion scale, *Icerya purchasi* Mask., and immediately upon hatching the small pinkish larvæ enter the sac and feed on the eggs and young scale insects. As they are thus hidden, the work is often observed. The full-

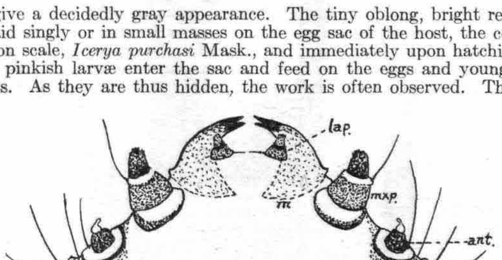

Fig. 299.—Head of the larva of vedalia, *Rodolia cardinalis* (Mulsant); ant, antenna; lap, labial palpus; m, mandible; mxp, maxillary palpus; o, ocelli.

grown larvæ are 5–7 mm. long, pinkish, with black markings and often a bluish bloom. The pupal stage is passed in the last larval skin and occurs anywhere on the infested plants. The success of this insect is due to the great prolificness, the rapidity of development, hardiness, and the greedy appetites of both young and parents. It soon completely destroys the host and then dies for lack of food, so it is necessary for the State Insectary to

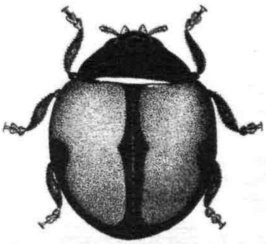

FIG. 300.—Kœbele's ladybird, *Novius kœbelei* (Olliff). Male.

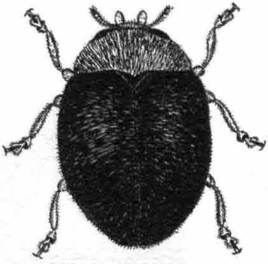

FIG. 301.—Blaisdell's ladybird, *Lindorus lophanthæ* (Blaisdell).

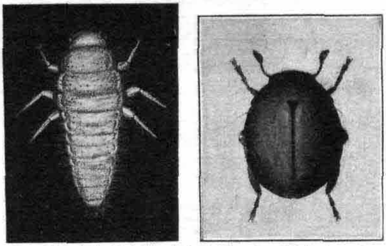

FIG. 303.—The Catalina ladybird beetle, *Delphastus catalinæ* (Horn). Larva and adult. (After H. S. Smith and E. J. Branigan.)

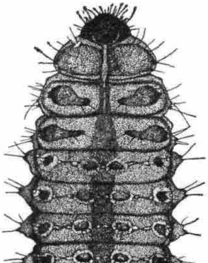

FIG. 302.—*Larva of the black ladybird, Rhizobius ventralis* (Er.).

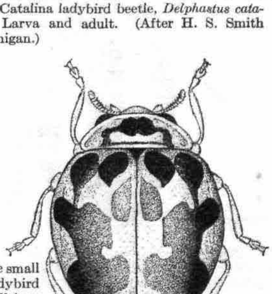

FIG. 304.—The small ashy gray ladybird beetle, *Psyllobora viginti-maculata* (Say) form *tædata* Lec.

artificially propagate a few all the time to insure a supply to combat the ever appearing infestations of the cottony cushion scale in ornamental plantings and orchards. The above species has been greatly aided by **Kœbele's ladybird,** *Novius koebelei* (Olliff) (Fig. 300), a closely related

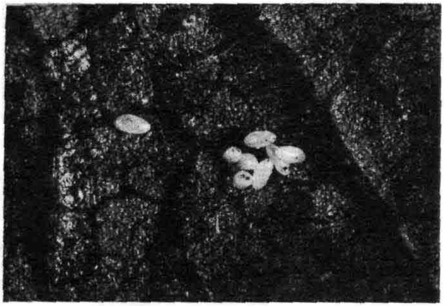

FIG. 305.—Eggs of *Psyllobora viginti-maculata* (Say) form *tædata* Lec.

species imported from Australia into California in 1892. The latter is somewhat smaller, bright red, the head and thorax black, the elytra with the margins, and a pair of black spots which are marginal in the male and dorsal in the female. The larvæ are bright cardinal red. The beetle feeds on the cottony cushion scale and is similar in habits and effectiveness to the vedalia.

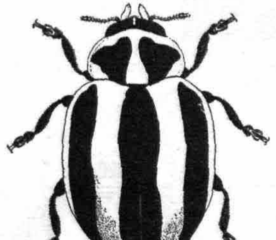

FIG. 306.—The striped ladybird beetle, *Ceratomegilla vittigera* (Mann.).

Blaisdell's ladybird, *Lindorus lophanthæ* (Blaisdell) (Fig. 301), is 2 mm. long, reddish brown, the elytra shining, black, and a black blotch frequently on the pronotum. It is common in California and preys extensively on mealybugs, and soft and armored scales including all the common species of the latter.

The black ladybird beetle, *Rhizobius ventralis* (Er.)[1] (Figs. 290, G; 302), is 2-2.5 mm. long, shiny or often velvety black, with the abdomen reddish. The larvæ average 6 mm. in length and are brown or black covered with many tubercles from which arise long simple spines. They commonly occur in the egg masses of mealybugs, under the shells of black, brown apricot, and other soft scales, or on the infested limbs, feeding directly on the hosts.

[1] E. O. Essig, *P. C. Jour. Ent.*, 11, p. 270, 1910.

The species was introduced from Australia in 1892 and is most valuable as a destroyer of the black scale in California where it is well established as far north as the San Francisco Bay region.

The Catalina ladybird beetle, *Delphastus catalinæ* (Horn)[1] (Fig. 303), is 1.5 mm. long, oblong, shiny pale or dark brown, with a dark narrow space at the bases of the elytra and the middle of the pronotum dusky. It normally feeds on Kellogg's white fly, *Pealius kelloggi* (Bemis), but also preys on other aleyrodids in Southern California and the adjacent islands.

The small ashy gray ladybird, *Psyllobora viginti-maculata* (Say) (Figs. 304, 305), is 1.9–2.6 mm. long, pale brown, with irregular darker and paler spots of many shades on the dorsum. The larvæ are pale yellowish gray and the eggs oval and pearly white. The species has often been reported as feeding on red spiders and scale insects, but it

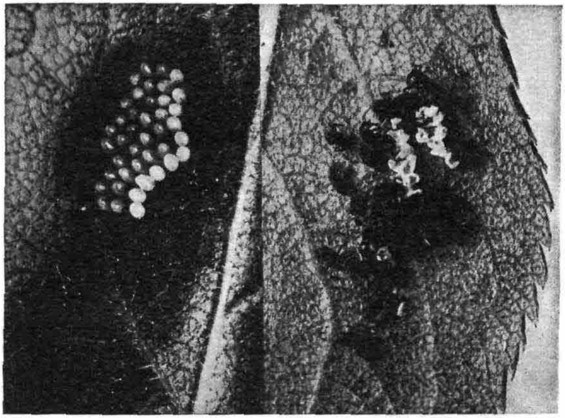

FIG. 307.—Eggs and newly hatched larvæ of the convergent ladybird beetle, *Hippodamia convergens* Guérin.

probably confines its attention largely to the spores of various fungi such as the smut fungus, powdery mildews, and so forth, as pointed out by W. M. Davidson.[2] It ranges throughout the United States. The western form *tædata* Lec. occurs abundantly throughout our region.

The spotted ladybird beetle, *Ceratomegilla fuscilabris* (Muls.) (*Megilla maculata* De G.), is 4.7–6.2 mm. in length, varying from yellow to red above and black beneath, the pronotum with two large blacks spot which may be fused, each elytron with distinct black spots, the two medial marginal spots fused when at rest. This is one of the commonest species throughout North America and the typical form occurs in New Mexico, Arizona, and California. It commonly preys on aphis. **The striped ladybird beetle,** *Ceratomegilla vittigera* (Mann.) (*Paranemia*) (Fig. 306), is 4–4.5 mm. long, black, the

[1] H. S. Smith and E. J. Branigan, *Mthly. Bul.*, Cal. State Com. Hort. 5, p. 448, 1916.
[2] *Ent. News*, 32, p. 83, 1921.

pronotum reddish, spotted with black, and the elytra reddish with three black vittæ which do not reach the apex. It occurs often in colonies in damp places and along the coast of Southern California and also in Arizona and Colorado. It feeds on aphis.

The members of the large genus *Hippodamia* [1] are elongate-oval, fairly large, black, with yellow or red pronotum and elytra, usually marked with black. **The convergent ladybird beetle,** *Hippodamia convergens* Guérin

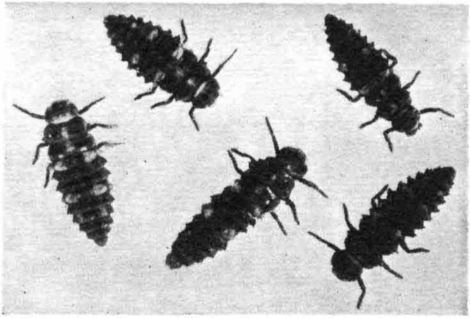

FIG. 308.—Larvæ of the convergent ladybird beetle, *Hippodamia convergens* Guérin.

(Figs. 290, A–D; 307, 308, 309), is the commonest species throughout North America. The body is 6–8 mm. long, black, the pronotum with two oblique white lines, the elytra yellow, orange, or red with twelve small oval or circular black spots, and also a small black scutellar spot. The eggs are elongate, pointed at one end, truncate at the base, 1.4 mm. long, and usually laid in clusters of 5–30 on the leaves, limbs, trunks of plants, or other convenient objects. Each female lays from 200 to 500 or more eggs a season with only one mating necessary. The larvæ are elongate, flat, velvety black or grayish with two small often indistinct orange spots on the prothorax and four larger orange spots on the back. When mature they average 7–10 mm. in length. The pupæ are red and black. In some parts of the west, particularly in the Sierra Nevada and Coast Range Mountains of California, the adults assemble in certain warm spots in the canyons of rivers and creeks during the late fall in countless numbers and crawl among the leaves and plants

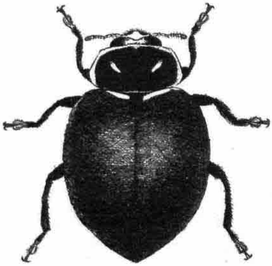

FIG. 309.—The spotless form of *Hippodamia convergens* Guérin which is commonly known as *H. ambigua* Lec.

[1] P. H. Timberlake, "Notes on N. A. Species of *Hippodamia*." *Jour. N. Y. Ent. Soc.*, 27, p. 162, 1919.

for hibernation, where in the high altitudes, they are deeply buried under the snow. In the spring they disperse over wide areas and their progeny, or a part, return to the mountains, while others are found in the valleys throughout the winter. The species multiplies rapidly and feeds extensively on very many species of aphis and on the eggs and larvæ of the Colorado potato beetle and the alfalfa weevil. According to

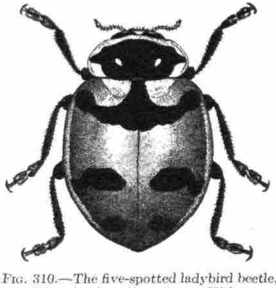

FIG. 310.—The five-spotted ladybird beetle, *Hippodamia quinquesignata* Kirby.

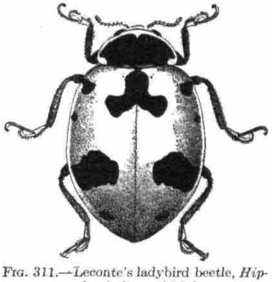

FIG. 311.—Leconte's ladybird beetle, *Hippodamia lecontei* Muls.

C. P. Clausen[1] each larva consumes about 25 aphis and each adult, 56 aphis daily. It occurs in every Western State, together with the form *ambigua* Lec., which has no black spots on the elytra. There are at least 5 other forms or varieties.

The five-spotted ladybird beetle, *Hippodamia quinquesignata* Kirby (Fig. 310), is 4.2–6.2 mm. in length, and exceedingly variable in the elytral markings, ranging from an im-

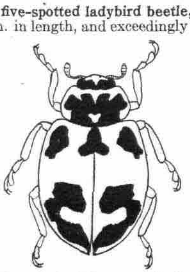

FIG. 312.—The parenthesis ladybird beetle, *Hippodamia parenthesis* (Say).

FIG. 313.—The sinuate ladybird beetle, *Hippodamia sinuata* Muls. var. *trivittata* Casey.

maculate form to forms with three distinct black elytral bands. It is a common western species occurring in practically every Western State and particularly well represented in the Rocky Mountains. P. H. Timberlake[2] recognizes nine geographical races. It

[1] *Univ. Cal. Pub. Tech. Ser. Ent.*, 1, p. 266, 1916.
[2] *Jour. N. Y. Ent. Soc.*, 27, p. 171, 1919.

feeds on aphis. **Leconte's ladybird beetle,** *H. lecontei* Muls. (Fig. 311), is often mistaken for the preceding species. It is 4.9–6 mm. long with a distinct three-lobed scutellar black spot, a humeral spot, postmedian spots or band, and a subapical spot on the elytra. There are specimens with the scutellar spot broken into three in most localities. It is a typical western mountain species occurring in practically every State and there are many races of this species. **The parenthesis ladybird beetle,** *H. parenthesis* (Say) (Fig. 312), is 3.8–5 mm. long and characterized by three basal spots and two apical marks resembling parentheses. The latter are often divided or extended into a black blotch. This is a very common North American species and occurs in every Western State and north into Alaska. It preys chiefly on aphis. **The sinuate ladybird beetle,** *Hippodamia sinuata* Mulsant (Fig. 313), is 5 mm. in length, quite reddish, the markings varying from four spots to three more or less wavy black stripes, the two outside stripes curving with the margins of the wings and nearly meeting apically. A typical form or race occurs in practically every Western State, the true form in New Mexico and Arizona, the var. *trivittata* Casey, in the San Francisco Bay region, California, and the var. *spuria* Lec. in Oregon, Washington, British Columbia, and the Rocky Mountain region.

The genus *Coccinella* is also a very common one. The adults are more shortened and convex than those of the preceding forms. The elytra are yellow or red and immaculate, or with black spots. **The common red ladybird beetle,** *Coccinella transversoguttata* Fald., is 6–7.5 mm. long, nearly hemispherical, the elytra spotless or with a long transverse subbasal spot, a shorter transverse spot near the middle, and another near the apex. It ranges throughout North America and Siberia and is represented by many races and varieties. **The California ladybird beetle,** *C. californica* Mann.

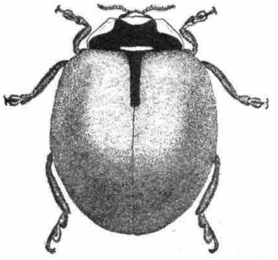

FIG. 314.—The California ladybird beetle, *Coccinella californica* Mann.

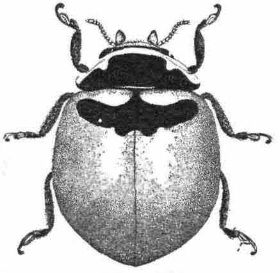

FIG. 315.—The Julian ladybird beetle, *Coccinella perplexa* Muls. var. *juliana* Muls.

(Fig. 314), has no marks on the elytra and is the common one in California, Oregon, Washington, and British Columbia. The species is usually common everywhere and the adults often assemble in the higher mountains. They feed extensively on aphis. **The perplexing ladybird beetle,** *Coccinella perplexa* Muls. (Fig. 315), varies from having one transverse subbasal fascia to three fasciæ on the elytra. The species occurs in some form throughout Europe, Siberia, and much of North America. In the west it is chiefly found along the Pacific Coast where the var. *juliana* Muls. (Fig. 315), which has the single subbasal fascia, is predominant.

The western blood-red ladybird beetle, *Cycloneda munda* (Say) (Fig. 316), is 4.5–5.5 mm. long, nearly hemispherical, and pale to very bright red. It is widely distributed throughout North America and is common in the Western States. It feeds on red spiders, aphis, and scale insects, and is often present in considerable numbers. *C. sanguinea* (Linn.) has usually been confused with the above species. It ranges from South America into Arizona and the United States east of the Rocky Mountains.

The ashy gray ladybird beetle, *Olla abdominalis* (Say) (Fig. 290, H), is 4–6 mm. in length, nearly hemispherical, pale yellow with numerous small black spots on the pronotum and elytra. The larvæ are black with orange markings and 15 to 20 mm. long when mature. They are especially fond of the walnut aphis which they devour in great numbers as well as other aphis. The species ranges throughout much of North America and is recorded in the west in New Mexico, Arizona, Colorado, and California. A black form with two large red spots on the elytra known as *plagiata* Casey (Fig. 317), frequently occurs.

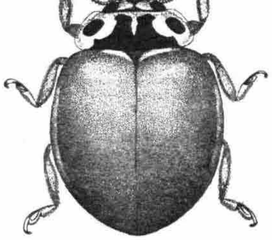

FIG. 316.—The western blood-red ladybird beetle, *Cycloneda munda* (Say).

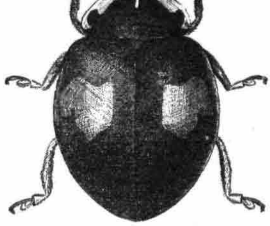

FIG. 317.—The eyed ladybird beetle, *Olla abdominalis* (Say) form *plagiata* Casey.

The two-spotted ladybird beetle, *Adalia bipunctata* (Linn.) (Fig. 318), is 3.8–5.2 mm. long, the prothorax irregularly margined white, and the red elytra with two round median black spots. It is a common species in Europe and North America and occurs along the Pacific Coast from California to British Columbia and in most of the other Western States. It preys on aphis. **The frigid ladybird beetle,** *Adalia frigida* Schneider, is 3.2–4.5 mm. long, the head and prothorax largely white or with zigzag black markings somewhat in the form of an "M" on the pronotum, and the elytra red and varying from immaculate to two faint dark spots or with a median broken band and a subapical transverse spot. It is a common predator on aphis and occurs throughout the west. The phase *humeralis* (Say) (Fig. 319), which is entirely black with two red spots on the elytra, also occurs in New Mexico, Arizona, Utah, and California.

The pine ladybird beetle, *Cleis picta* (Randall) (*Harmonia*), is 3.5–5 mm. long, oval, depressed, black, head yellow with two interrupted black vittæ, thorax spotted yellow, elytra yellow, immaculate in the male and more or less variegated with black in the

female, and the legs orange. It feeds on aphis, *Dilachnus* spp., on pine trees, and occurs throughout North America and is fairly common in Arizona, California, Oregon, Washington, and British Columbia. **The interrupted ladybird beetle,** *Neomysia interrupta* Casey, is 6–10 mm. in length, dull yellowish red with or without a black median blotch on the pronotum, and with two or three interrupted narrow longitudinal lines on the elytra. It has been observed feeding on woolly apple aphis and other aphis in New Mexico, Colorado, Arizona, California, and Nevada.

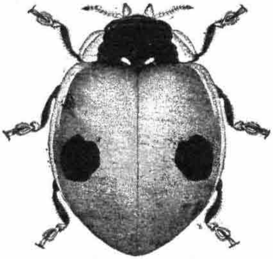

FIG. 318. — The two-spotted ladybird beetle, *Adalia bipunctata* (Linn.).

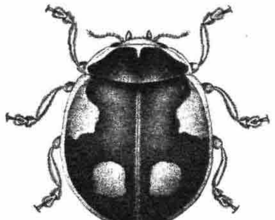

FIG. 319.—The frigid ladybird beetle, *Adalia frigida* Schneider phase *humeralis* (Say).

The plagiate ladybird beetle, *Axion plagiatum* (Olivier) (Figs. 320, 321), is 5–6.7 mm. long, hemispherical, shining black with two large orange or reddish spots just in front of the median dorsum of the elytra, and the thorax reddish beneath. It commonly feeds on *Kermes cockerelli* Ehrh., on oak trees, where it often hibernates in considerable numbers under the bark and in other protected places. It occurs in Texas, New Mexico, Arizona, and California in various phases.

FIG. 320.—The plagiate ladybird beetle, *Axion plagiatum* (Olivier). (After Quayle.)

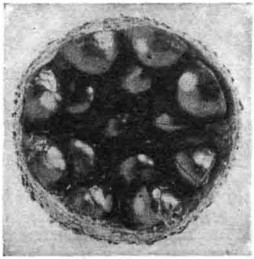

FIG. 321.—The plagiate ladybird beetle, *Axion plagiatum* (Olivier). Adults hibernating in acorn cup hanging on valley oak tree. This is a common habit of this species in California.

The two-stabbed ladybird beetle, *Chilocorus bivulnerus* Muls. (Fig. 290, J; 322), is 4–5 mm. long, nearly hemispherical, shining black, with two

small red spots on the elytra in front of the middle, punctation close and deep, and the abdomen red. The eggs are cylindrical, orange, and 1.2 mm. long. They are laid on their sides singly or in small groups in the crevices of the bark. The larvæ are covered with many long branched spines, black, with median yellow transverse band and measure 5 to 7 mm. when full grown. They pupate in the last larval skin. This species occurs throughout North America and is common in the west particularly in New Mexico, Arizona, California, Nevada, Oregon, Washington, and British Columbia. It feeds extensively on the armored and unarmored scales including the greedy, ivy, San José, Howard's, Italian pear, oyster shell, black willow, fig, elm, and brown apricot, is abundant in the orchards, ornamental plantings and forests, and is very beneficial. *C. cacti* Linn. is similar to the above but has most of the sterna as well as the abdomen red. The variety *confusor* Casey is common in New Mexico, Arizona, and Southern California where it feeds extensively on the cottony cochineal scales on cacti, the red date palm scale, the mesquite scale, *Xerophilaspis prosopidis* Ckll., and the palo verde scale, *Pseudodiaspis parkinsoniæ* (Ckll.).

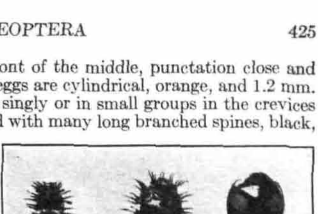

FIG. 322.—The two-stabbed ladybird beetle, *Chilocorus bivulnerus* Mulsant. Larvæ, pupæ and adults.

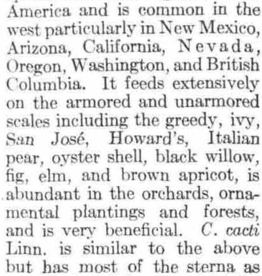

FIG. 323.—The variable ladybird beetle, *Exochomus marginipennis* Lec. var. *californicus* Casey.

The variable ladybird beetle, *Exochomus marginipennis* Lec., is 3 mm. long, broadly oval, shining black with variable red markings consisting of red elytra with two dark transverse bands or black spots, or black elytra with a marginal stripe and two dark subapical spots. There are a number of varieties in our region including *californicus* Casey (Fig. 323). They feed on the cottony cochineal, San José, Italian pear, and other scales, and range in New Mexico, Arizona, California, and Nevada, in the west. The typical form is eastern.

The steel-blue ladybird beetle, *Orcus chalybeus* (Boisduval), is 3.5 mm., nearly hemispherical, metallic steel-blue or emerald green, the males often with yellow on the

front of the pronotum. The apical portion of the abdomen is dull red or orange. The eggs are light yellow and attached by one end in small clusters. The larvæ are yellow or orange with the head and portions of the pronotum and dorsum of the abdomen black. The body is covered with stout branched spines and 8 mm. long when mature. This species was introduced from Australia into California in 1892 to prey on the black, red, and purple scales. It was established in various parts of Southern California from

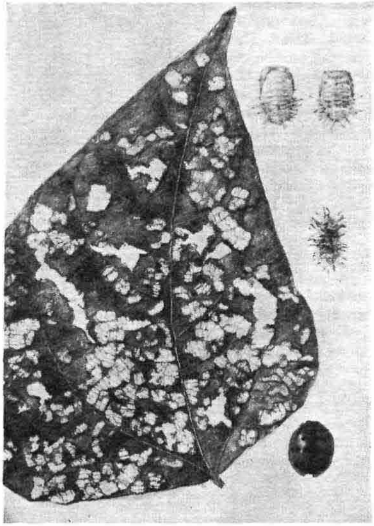

FIG. 324.—The Mexican bean beetle, *Epilachna corrupta* Mulsant. Pupæ, larva, adult and the characteristic work of the larvæ on a bean leaf.

San Diego to Santa Barbara, but persists now only at Carpinteria and Goleta where it is often present in considerable numbers in the citrus orchards.

The Mexican bean beetle or the bean ladybird, *Epilachna corrupta* Muls.[1] (Fig. 324), is the most destructive member of the family in the west and it is proving to be a serious pest wherever found. The adults are 6.4 -7

[1] C. P. Gillette, Bul. 19, Colo. Agr. Exp. Sta., p. 25, 1892.
D. E. Merrill, *The Bean Beetle.* Bul. 106, N. M. Agr. Sta. 1917.
F. H. Chittenden "Bean Ladybird and Its Control." *Farmers' Bul.* 1074, U. S. Dept. Agr. 1921.
F. H. Chittenden and H. O. Marsh, *The Bean Ladybird.* Bul. 843, U. S. Dept. Agr. 1920.
G. M. Bentley, "The Mexican Bean Beetle." Bul. 41, Vol. 11, No. 2, *Tenn. State Board Ent.*, 1922.
F. L. Thomas, *Life History and Control of the Mexican Bean Beetle.* Bul. 221, Alabama Agr. Exp. Sta. 1924.

mm. in length, oval, convex, yellow or grayish brown, and each elytron with 8 small black oval spots. The eggs are pale yellow, elliptical, about twice as long as the diameter, and attached by the apex in masses of 5 to 75, usually on the undersides of the leaves. Egg-laying begins in April or May and continues until fall. The larvæ are 5–7 mm. long when mature and are yellow, armed with long stout branched spines which are black at the tips. Pupation occurs in the last larval skin which is attached to any convenient object. There are usually two broods a year. The adults hibernate in trash about the fields. They feed on the upper, and the larvæ on the lower, epidermis of the leaves, producing very characteristic, thin, transparent, rectangular or irregular areas between the vines. They also feed on the pods. As the common name implies, this species feeds chiefly on common varieties of garden and field beans but also attacks lima beans, cowpeas, hyacinth beans, soy beans, alfalfa, kudzu, white melilotus, and similar plants. The distribution includes the Southern States, Mexico, Texas, New Mexico, Colorado, Utah, and Arizona. Control may be obtained by dusting with 1 part of calcium arsenate and 4 to 8 parts of hydrated lime, or by spraying with 1 pound of magnesium arsenate to 50 gallons of water.

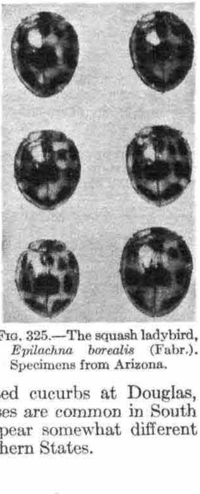

FIG. 325.—The squash ladybird, *Epilachna borealis* (Fabr.). Specimens from Arizona.

The squash ladybird, *Epilachna borealis* (Fabr.) (Fig. 325), is distinguished from the above by its larger size and its larger black spots, of which there are 7 on each elytron, there being but one rather than two apical spots. W. W. Jones[1] first reported this species in the west as abundant and destructive to all varieties of native and cultivated cucurbs at Douglas, Arizona, in 1921. This species and its color phases are common in South America, Central America, and Mexico, and appear somewhat different from the species common to the Eastern and Southern States.

TENEBRIONIDÆ.[2] Darkling Ground Beetles.

This is a large family of small or mostly large, awkward, slow moving, usually black or brown beetles, which occur chiefly on the ground. Many have the interesting habit of standing on their heads and emitting an offensive protective vapor. The larvæ are often cylindrical and shining, somewhat resembling wireworms, hence the name "false wireworms" has been given them. The members are chiefly nocturnal, but great numbers

[1] *Jour. Econ. Ent.*, 17, pp. 417–418, 1924.

[2] F. E. Blaisdell, Sr., *Mon. Rev. of the Tribe Eleodiini of U. S., Lower California and Adjacent Islands.* Bul. 63, U. S. Nat. Mus. 1909. "Studies in *Alaudes.*" *Trans. Am. Ent. Soc.*, 45, p. 307, 1919 "Syn. and Review of the Species of *Cœlus.*" *Trans. Am. Ent. Soc.*, 45, p. 315, 1919.

J. S. Wade, "Ecology of the *Tenebrionidæ.*" *Ent. News* 32, p. 1, 1921.

R. E. Campbell, "Notes on Injurious Southwestern *Tenebrionidæ.*" *Ent. News*, 35, 1924, p. 1.

often appear during the day. The normal food is dead or decaying vegetable matter, but some feed on cereals and others often attack growing plants and become serious pests. Poison bran mash, consisting of 25 pounds of bran, 1 pound sodium arsenite, 2 quarts of blackstrap molasses, and 3 to 4 gallons of water, has proven an effective bait for the latter.

FIG. 326.—The small darkling ground beetle, *Metoponium abnorme* (Lec.).

The small darkling ground beetle, *Metoponium abnorme* (Lec.) (*Eurymetopon*)[1] (Fig. 326), is 7 mm. long, smooth, black or dark brown, with the legs slightly reddish. This species occurs in Southern California and Arizona and has been observed as injurious to the buds of grapevines, the bark of young grapefruit trees, and the fruit of strawberries and tomatoes. *M. cylindricum* (Casey) has been observed injuring foliage of prune trees in Southern California.[2]

The ironclad beetle, *Phlœodes pustulosus* Lec. (Fig. 327), is 15–23 mm. long, flattened, very rough dorsally and exceedingly hard, often too hard to pin without great difficulty. The prothorax is very much constricted at the base and widest near the front. The color is dull grayish black, often with the bases and apices of the elytra whitish, and one pair of short oblique black lines on the pronotum, three pairs on the elytra and two pairs of small black spots apically. Mounted specimens do not always show these mark-

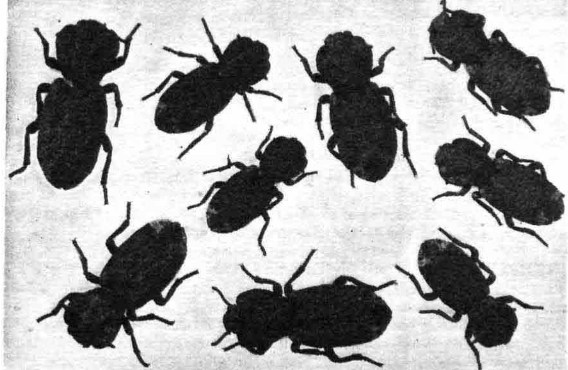

FIG. 327.—The ironclad beetle, *Phlœodes pustulosus* Lec.

ings. The adults occur under the bark of dead trees, logs, and stumps, and can often be taken in great numbers during the winter. The food consists of woody fungi and probably decayed wood. This is the commonest species ranging throughout much of

[1] E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 291. Referred to as *Eurymetopon bicolor* Horn.

[2] *Insect Life*, 5, p. 350, 1893.

California. **The diabolical ironclad beetle,** *P. diabolicus* Lec., is similar but entirely black. It occurs in like surroundings in Southern California. During the summer evenings it can occasionally be taken on the ground. **The plicate beetle,** *Noserus plicatus* Lec., is 12–14 mm. long, similar to the preceding but has the warty areas arranged in somewhat definite longitudinal ridges. It occurs under the bark, chiefly of oak trees, throughout California.

Members of the genus *Eleodes* are medium to very large, robust, usually smooth shining beetles. They are typically semi-arid and desert species and often occur in countless numbers in such localities, traveling day and night during the migrating periods in the spring and early summer, although they may be found in scattering

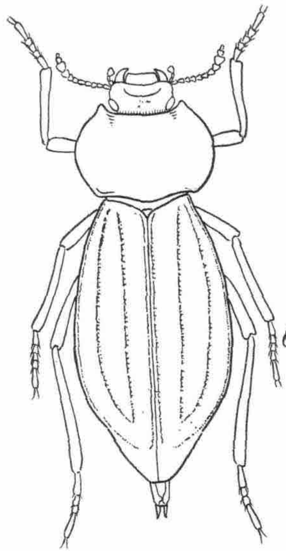

FIG. 328.—*Euschides lecontei* (Horn), a California darkling ground beetle.

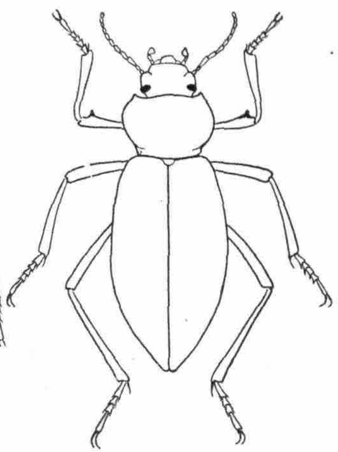

FIG. 329.—The dentate eleodes, *Eleodes dentipe* Esch. (Drawing by Carl Fuchs.)

numbers throughout the year. *E. acuticauda* Lec. measures 16–29 mm., is elongate, smooth, shining black, the elytra produced into a point posteriorly. It is a very common species in Southern and Lower California. **The carbon beetle,** *Eleodes carbonaria* (Say), is 15.5–20.5 mm. in length, moderately elongate, smooth, shining, the elytral punctures in series. It is common in Texas, New Mexico, Colorado, Arizona, and is recorded as abundant in Idaho by C. Wakeland. **The cordate darkling ground beetle,** *E. cordata* Esch., is 13–17 mm. long, subovate, shining, black, twice as long as wide, the prothorax strongly constricted at the base, the dorsum coarsely punctate and rugose. The adults are very common in California and range north into British Columbia. **The dentate eleodes,** *E. dentipes* Esch. (Fig. 329), is 18–28 mm. long, elongate or ovate, smooth, shining black, a variable species with a large tooth on the anterior femora of both

sexes. This tooth, however, also occurs in a number of other species. It is very common under rocks, logs, in stumps, dry leaves, or walking on the ground, throughout all parts of California, ranging to the extreme northern coastal areas. *E. extricata* (Say) is 12–17 mm. long, about twice as long as wide, and smooth, shining black. The front femur of the male is armed. This very common species is often abundant in New Mexico, Colorado, Wyoming, Montana, British Columbia, Utah, and Arizona. The larvæ are at times injurious to sprouted grain. *Eleodes femorata* Lec. (Fig. 330) is 22–25 mm. in length, and is a large, elongate, smooth shining black species. The femora

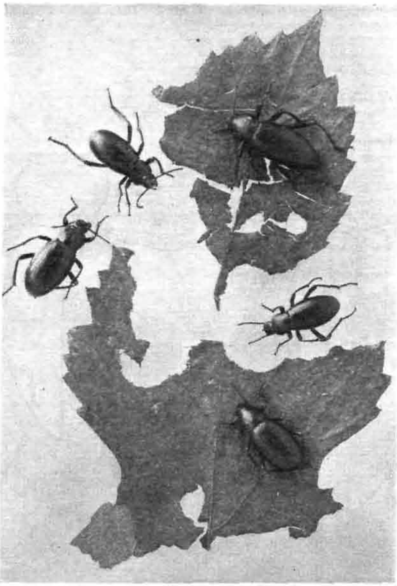

FIG. 330.—*Eleodes femorata* Lec. and injury to grape leaves.

of both sexes are armed with small teeth, the anterior tibial spurs about equal in size. It has completely defoliated grapevines some years in the San Joaquin Valley, California. It also ranges into Arizona. **The gigantic eleodes,** *E. gigantea* Mann., is a large, elongate, smooth, moderately shining species 30–35 mm. long, which is fairly common in California. C. F. Gissler[1] describes the eggs as white, oval-elongate, 0.80 x 0.35 mm., and the young larvæ as nearly white, long and slender, nearly flat, widest at the head and tapering to the tail, and in confinement cannibalistic in habits. *E. hispilabris* (Say) is 20–28 mm. long, elongate-ovate, smooth, moderately shining black, sometimes reddish, along the elytral suture. It is a common injurious species ranging in Texas, New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, Arizona, Washington, and

[1] *Bul. Brooklyn Ent. Soc.*, 1, p. 18, 1878.

British Columbia. *Eleodes humeralis* Lec. is 14–21 mm. in length, elongate, more or less opaque, and black with granular surface. It is a common and at times injurious species in British Columbia, Washington, Oregon, California, Nevada, Idaho, Utah, and Colorado. *E. vandykei* Blaisdell is 15–16 mm. long, more or less shining, with elytra densely granular. The larvæ are yellowish and are reported by J. A. Hyslop [1] as injurious to oats in Washington. The species ranges also in the higher altitudes of Idaho, Oregon, and California. *E. obscura* (Say) is 25–34 mm. in length, elongate, black or brownish, the surface of the elytra more or less striate and granular. It occurs throughout the entire western area and is at times injurious to crops. *E. obsoleta* (Say) measures 12–18 mm., is slightly elongate, shining or dull black, often reddish along the elytral suture. The elytra are striate and rough. It is common on both slopes of the Rocky Mountains from New Mexico to Montana. *E. omissa* Lec. (Fig. 331) is common and often injurious to fruit trees and vines throughout California. *Eleodes opaca* (Say) [2] is 10–14 mm. long, oval, opaque, black, sparsely clothed with whitish hairs, the dorsum of the elytra flat. It ranges along the Rocky Mountains and occurs in the Western States of New Mexico, Colorado, Wyoming, and Montana. The larvæ do serious injury to seed wheat, particularly if it remains in the dry ground some time before germination, and also cut off the young plants just above the seed and the older stalks in the spring. They naturally feed on native grasses and seeds. *E. pimelioides* Mann. is 12–15 mm. long, ovate, opaque, black, the elytra coarsely granulate. It occurs in practically every Western State but is most abundant in the northwest where it is at times injurious.

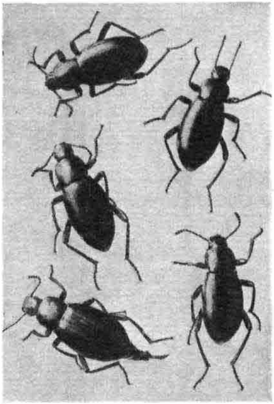

FIG. 331.—*Eleodes omissa* Leconte.

The grain seed beetle, *Embaphion muricatum* (Say),[3] is 15–18 mm. in length, oval to oblong-oval, brown to dull black, the margins of the elytra broad and thin. The eggs are oblong, white, or pale yellow, and laid singly or in small clusters in the soil. The larvæ are reddish with the legs and head darker, chitinous, and when mature measure 27 mm. They normally feed on seeds, roots, and plants of grasses and weeds, and often destroy newly sown and germinating wheat, corn, and barley. The species occurs in the plains areas of the middle west and ranges west into New Mexico, Colorado, and Montana.

The members of the genus *Coniontis* are small to medium size, somewhat cylindrical, elongated, smooth, black, or bluish. *C. globulina* Casey injures young tomato plants, *C. muscula* Blaisdell eats off young lima bean plants and *C. subpubescens* Lec. injures young sugar beets all in Southern California.

The ciliated sand beelte, *Cœlus ciliatus* Esch., is 5–7 mm. in length, oval, convex, shiny black or brown, with the margins, venter, and legs clothed with long, soft, reddish hairs. It is common in the dry sand dunes along the California coast. *Ulus crassus* (Lec.) is 7–9 mm. long, black or dull brown, the elytra finely striated, and the body sparsely clothed with short brown hairs. The adults are often injurious to young lima beans, cucumbers, muskmelons, tomatoes, and other plants which are usually girdled at or below the surface of the soil in California and Arizona.

The small darkling ground beetles belonging to the genus *Blapstinus* are becoming quite serious pests in many sections. The adults, black or bluish black often with

[1] Bul. 95, pt. 5, Bur. Ent. U. S. Dept. Agr., p. 74, 1912.
[2] J. W. McColloch, *Jour. Econ. Ent.*, 12, p. 183, 1919.
[3] J. S. Wade and A. G. Böving, *Biology. Jour. Agr. Research*, 22, p. 323, 1921.

reddish legs, are frequently very numerous in the spring and early summer and attack many kinds of crops, usually girdling the young plants at the surface of the soil (Fig. 332). They can be controlled by use of the poison bran mash. Young tomato and pepper plants are effectively protected by wrapping the main stem from the roots to the upper branches with tissue paper at the time they are transplanted. *Blapstinus coronadensis* Blaisd. and *B. dilatatus* Lec. (Fig. 332) are recorded as girdling young peppers in Southern California by R. E. Campbell.[1] *B. pimalis* Casey cuts off young cotton plants in Arizona and also occurs in New Mexico. *B. pulverulentus* Mann. is 5 mm. long and a black or bluish species common in New Mexico, Arizona, and California, and has been observed to be injurious to tomato, strawberry, and cucumber plants in the latter State. *B. rufipes* Casey is 5 mm. long, and bluish black with reddish legs. It has been observed girdling young hop and tomato plants in California and also occurs in Arizona.

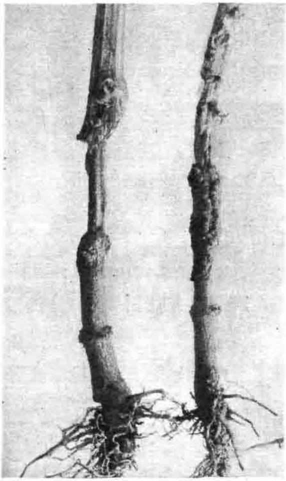

FIG. 332.—Young pepper plants girdled by *Blapstinus coronadensis* Blaisd. and *B. dilatatus* Lec. (Photo furnished by R. E. Campbell.)

The kelp beetles, *Phaleria limbata* Horn and *P. rotundata* Lec., are small, pale or dark brown, robust species, 5–7 mm. long, which often occur in great numbers under decomposing kelp on which they feed along the ocean beach of Southern California.

The two-banded fungous beetle, *Alphitophagus bifasciatus* (Say), is 3 mm. in length, elongate-oval, convex, reddish brown with two wide black bands across the elytra. It normally feeds on moist tree fungi, but also occurs in damp cellars, storehouses, mills, and houses, and feeds on refuse of cereals and cereal products which are fermenting or decaying. It is cosmopolitan and occurs along the Pacific Coast in Oregon and California.

The broad-horned flour beetle, *Gnathocerus cornutus* (Fabr.), is 3-4 mm. long, slender, shining brown, the males with broad mandibular horns. It is a cosmopolitan species infesting cereals and cereal products and also occurs under the bark of trees in California.

The red flour beetle, *Tribolium ferrugineum* (Fabr.), is 3 mm. in length, slender, flattened, various shades of pale and dark reddish brown with the head and thorax darkest. It is a cosmopolitan pest of cereals and cereal products, peanuts, almonds, insect museum specimens, drugs, seeds, and so forth, and occurs throughout the entire country. **The confused flour beetle,** *T. confusum* Duval, is about the same size but paler in color. It has similar habits and distribution. Both species can be killed by fumigation or heating to 48° C. *T. madens* (Charp.), another cosmopolitan species, occurs in cereals in the west. Seed cereals can be protected by treating with 2 ounces of copper carbonate dust per bushel, as used for the prevention of bunt.

[1] *Jour. Econ. Ent.*, 15, p. 363, 1922.

The yellow meal worms, *Tenebrio molitor* Linn., and *T. obscurus* Fabr., are 13 to 15 mm. long, somewhat flattened, brown or black, with the elytra distinctly striate. The larvæ are elongated, convex above and flat beneath, chitinous, yellow or brown, with darker lines at the joints and 20–25 mm. long when mature. They live in cereals and cereal products, fertilizers, and seeds, and are often very serious pests. They are cosmopolitan and occasionally found throughout the west.

The woolly ground beetle, *Cratidus osculans* Lec., measures 12–16 mm., is robust, black, sparsely covered with fine long reddish brown hairs. The species is very common in California and often occurs on the roads and paths in the evenings or early mornings.

PTINIDÆ.[1] Ptinid Beetles, Spider Beetles.

The storehouse beetle, *Gibbium psylloides* (Czemp.) is a very small species with the upper surface glabrous and the venter with dense short yellow hairs. It is a cosmopolitan species occurring in California and other Western States, inhabiting houses, stores, warehouses, and feeding on woolen fabrics and various dried animal products. *Mezium americanum* Lap. is 2.5–3 mm. long, dull yellow, the elytra shining black. It occurs throughout North America and is nearly cosmopolitan. It feeds on dried animal products and insect museum specimens, and according to E. A. Schwarz, also damages gilded chandeliers. *Sphæricus gibboides* (Boieldieu) is 1.8–2.2 mm. long, brown, clothed with yellow and pale brown scales. It has a world wide distribution and has been taken in caraway seeds, red pepper, herbariums, and insect collections in California. *Trigonogenius globulum* Solier is 2.5 mm., the prothorax and abdomen each nearly globular, the latter twice as wide as the former, pale or dark brown, densely clothed with pale yellow and brown scales arranged in spots on the elytra. The whitish larvæ pupate in a loose globular cocoon. The species has a wide European and American range, occurring in much of the west and reported from Oregon and California. It breeds in and feeds on animal fertilizers, dried animal products, herbarium and insect specimens, seeds, red pepper, and cereals. The writer has kept a living colony in a jar of fertilizer for eight years.

The white-marked spider beetle, *Ptinus fur* Linn., is 2–4 mm. in length, the head slightly wider than the thorax, reddish to pale brown, and densely clothed with yellow hair and with four white bands on the elytra. It is a cosmopolitan species occurring in old barns, houses, warehouses, storerooms, and feeding on dry vegetable and animal materials such as cereals and cereal products, seeds, insect, mammal and plant museum specimens, wool, and furs, and is often a serious pest.

ANOBIIDÆ. Death Watch or Drug Store Beetles.

The oak limb beetle, *Hedobia granosa* Lec. is 3–4.5 mm. long, black, slate or reddish, marked with patches of gray scales. It normally breeds in the dead limbs of coast live oak, California laurel, and California black walnut in California. *H. angulata* Fall is similar but more slender, the elytra black with two pale stripes. It breeds in the dead limbs of coast live oak

[1] H. C. Fall, "Rev. of the *Ptinidæ* of Boreal America." *Trans. Am. Ent. Soc.*, 31, p. 97, 1905.

in Southern California. *Ozognathus cornutus* (Lec.) is 1.5-2.8 mm. long, blackish brown, and sparsely pubescent. It has been reared from cynipid galls on oak trees in California.

The pine branch borer, *Ernobius californicus* Fisher, is 4-5 mm. long, elongate, brown, clothed with yellow pubescence. The larvæ mine the bark and outer wood of the branches of recently kill Jeffrey pine in Southern California. *E. champlaini* Fisher is 4-4.5 mm. in length, slender, black, with short grayish pubescence. It breeds in dead limbs of limber pine in Colorado. *E. cupressi* Van Dyke (*E. conicola* Fisher) is 5.5-6 mm. long, robust, shining brown with yellow pubescence. It breeds in the green and dry cones and dead wood of Monterey cypress in the native forests near Monterey, California. *Xeranobium desertum* Fall is 7-7.5 mm. long, cylindrical, brown, densely clothed with short gray hairs, and the elytra finely striated. It breeds in the stems of Kern greasewood in Southern California and Arizona. *Vrilletta decorata* Van Dyke is 5.5 mm. long, robust, black, the elytra variegated yellow. It breeds in dead coast live oak in the San Francisco Bay region, California.

The drug store beetle, *Sitodrepa panicea* (Linn.), is 2.4 to 3.7 mm. long, reddish brown, clothed with short dense pubescence. It is a cosmopolitan species which is often a serious pest in stores, warehouses, hotels, and residences where it feeds on all sorts of dried herbs, cereals, cereal products, spices, dried animal products, including wool, hair, leather, horn, plant, insect and mammal museum specimens, seeds, and candy. It can be controlled by fumigating or by heating to 49° C.

The cigarette beetle, *Lasioderma serricorne* (Fabr.), is 2 mm. long, robust, brown, clothed with short fine hair and without striated elytra. The small robust white larvæ are curved, clothed with long hair, and are responsible for the damage which the beetle does. Like the preceding this is a common cosmopolitan species, of similar habits, and particularly well known because of its injury to cured tobacco in leaf or in cigarettes, cigars, or plug. It also feeds on dried herbs, spices, cereals and cereal products, dried fruits, seeds, dried fish and meats, nuts, copra, hair, wool and other animal products, books, and museum specimens. As it breeds continuously and rapidly, completing a life cycle in about 45 days, it is able to do very serious damage. Fumigation of buildings and vacuum fumigation of manufactured articles give satisfactory control.

BOSTRICHIDÆ (*Bostrychidæ*). Branch and Twig Borers.

The lead cable borer or short circuit beetle, *Scobicia declivis* (Lec.) (*Sinoxylon declive* Lec.),[1] is 5-6 mm. long, cylindrical, dark brown or usually black, with antennæ and portions of the legs amber. The head is deflexed and hidden from above by the prothorax. The eggs are elongate, slender, with a small stipe, 2.1 mm. long, pale white or cream, with finely granulate surface. The larvæ are robust, larger at the anterior end, curved, dull white to pale yellow, and 10 mm. long when mature. They normally mine and completely destroy dead and seasoned oak, but also attack acacia, eucalyptus, maple, California laurel, chestnut, and other hard woods. The adults frequently burrow into living fruit trees and dry woods of all kinds, being attracted to alcohol and wine in oak casks or the stoppers in bottles con-

[1] H. E. Burke, R. D. Hartman, T. E. Snyder, Bul. 1107, *Prof. Paper*, U. S. Dept. Agr. 1922. Complete.

taining alcoholic liquids. They have also a peculiar habit of boring numerous holes in the aërial lead telephone cables through the lower sides where the hanger supports the cables. Moisture enters the cables and causes short circuits and serious trouble, occasioning considerable losses. The beetle is very common throughout California and southern Oregon. *S. suturalis* (Horn) (*Sinoxylon suturale* Horn),[1] is 5 mm. long, cylindrical, the head and abdomen black, the prothorax and posterior half of the elytra dark reddish brown, and the antennæ, legs, and anterior half of the elytra pale amber. The larvæ mine the canes of grapevines and the small limbs and twigs of oaks and acacia in California. *Dendrobiella sericans* (Lec.) (*D. asperum* Lec.) is a medium-sized brown beetle, the larvæ of which are

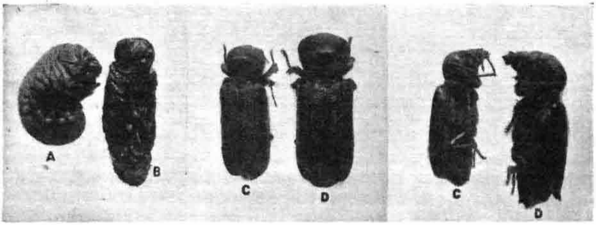

FIG. 333.—The California palm borer, *Dinapate wrighti* Horn. A, larva; B, pupa; C, adult male; D, adult female. Reduced. (After Garnett.)

7–15 mm. long and curved. They mine the dead wood of mesquite in Mexico, Texas, New Mexico, Arizona, and Southern California.

The western twig borer, *Amphicerus cornutus* (Pallas) [*Apate punctipennis* (Lec.)], measures 11–13 mm., is dark brown or black, cylindrical, the head deflexed, the front lateral margins of the pronotum with fine teeth, and the elytra with two pairs of blunt teeth above the apices. The larvæ breed in dead oak, mesquite, and other hard woods, while the adults have the curious habit of burrowing into the small twigs of living almond, apricot, fig, grape, orange, pear, and other fruit trees. The burrows usually start at a crotch or bud axil and reach a depth of from one to three inches. The twigs thus attacked usually break and die. Fortunately the beetles are not sufficiently abundant to cause serious damage. The species occurs in Mexico, Texas, New Mexico, Arizona, and Southern California. **The apple twig borer,** *A. bicaudatus* (Say), is a similar species which attacks the twigs of apple, cherry, pear, grape, osage orange, and other trees, in various parts of North America. It ranges west into Colorado and New Mexico. *A. teres* Horn bores into the bud axils of mesquite and kills the twigs. It has been taken at such work in Arizona by W. W. Jones and also occurs in Southern California. *Apatides fortis* (Lec.) riddles the sapwood of dead mesquite in Arizona, Utah, and Southern California.

[1] E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 239.

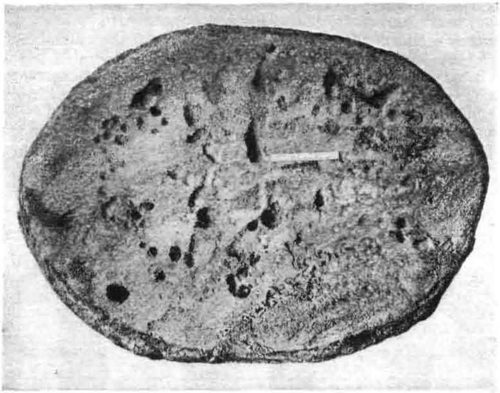

Fig. 334.—Larval burrows of the California palm borer, *Dinapate wrighti* Horn, in a cross-section of a trunk of the California fan palm.

Fig. 335.—The branch and twig borer, *Polycaon confertus* Lec. Larva and adult.

The California palm borer, *Dinapate wrighti* Horn [1] (Figs. 333, 334), is the largest known member of the family, and a most interesting species endemic only in small areas where the native fan palm still grows under natural conditions, and particularly in Palm Canyon, Southern California. The adults are 30–52 mm. x 14–18 mm., cylindrical, dark brown or black, the venter and appendages clothed with soft brown hairs, head deflexed, the front of the pronotum armed with conspicuous scale-like teeth, the elytra with a few distinct striæ and coarsely punctured, with two pairs of posterior horns, the upper pair often very much more developed in the males. The larvæ are robust, flat ventrally, pale yellow, and 45–65 mm. long. They completely mine the trunks of dead trees of the California fan palm, but never attack living tissues. The fly, *Sarcophaga helicis* Townsend,[2] is parasitic on this beetle.

The branch and twig borer, *Polycaon confertus* Lec.[3] (Figs. 335, 336), is 7–15 mm. long, cylindrical, mostly black with brown elytra, and the pronotum narrowest at the base. The eggs are elongate, slightly pointed at one end, smooth, white, and laid in the crevices and bark. The larvæ are robust, largest anteriorly, curved, whitish, and clothed with fine hair. They completely mine the heartwood of dead acacia, almond, apple, apricot, cherry, currant, fig, grape, California laurel, madrona, maple, manzanita, oaks, olive, orange, peach, pear, prune, rose, and many other trees and shrubs. The adults burrow into the twigs at a crotch or bud axil in all kinds of citrus, avocado, and deciduous fruit, nut, and olive trees, and cause severe pruning especially to young trees. Burning the prunings and dead brush around the orchards largely eliminates attacks. This species occurs throughout California and parts of Oregon. *P. stouti* Lec. (Fig. 337) is a larger, entirely black species, 17–20 mm. long, the head and pronotum coarsely, and the elytra finely, punctate. It breeds in dead eucalyptus, maple, oak, fruit trees, California laurel, madrona, manzanita, sycamore, and many of the native trees. The adults occasionally enter living trees as do those of the preceding species, but they have never been a pest. The

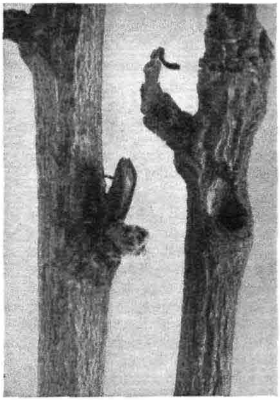

FIG. 336.—The branch and twig borer, *Polycaon confertus* Lec. Adult at work in a prune twig and empty burrow at the right.

[1] G. H. Horn, *Trans. Am. Ent. Soc.*, 13, 1886, p. 1. Orig. desc.
H. G. Hubbard, *Ent. News*, 10, p. 83, 1899.
J. O. Martin, *Bul. Brooklyn Ent. Soc.*, 12, p. 107, 1917.
R. T. Garnett, *Ent. News*, 29, p. 41, 1918.
[2] J. M. Aldrich, *Jour. Econ. Ent.*, 8, p. 244, 1915.
[3] E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 238. Bul. 283, Cal. Agr. Exp. Sta., p. 52, 1917.

species has, however, been injurious to cured hard woods in California. It occurs in Arizona, California, and Oregon.

The spotted limb borer, *Psoa maculata* (Lec.), is 6-7 mm. in length, dark bronzy, clothed with grayish hairs, the elytra black or bluish green with four or more whitish, yellow, or reddish spots. It breeds in the dead wood of oak, apple, grapevines, white sage, and other trees and shrubs in California.

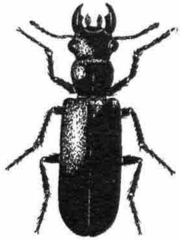

FIG. 337.—*Polycaon stouti* Leconte.

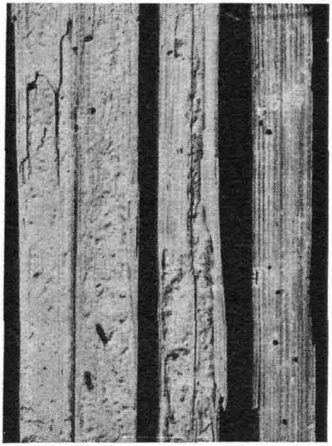

FIG. 338.—The brown powder post beetle, *Lyctus brunneus* (Stephens), and work on bamboo.

LYCTIDÆ.[1] Powder Post Beetles.

The brown powder post beetle, *Lyctus brunneus* (Stephens) (Fig. 338), is 4-5 mm. long, slender, brown, with head and prothorax black. It is a cosmopolitan species frequently taken in bamboo art goods and Mah Jongg sets from China and Japan. Everything excepting the outside shell is completely reduced to powder. If not too severely injured, the infested articles may be treated to a bath of gasoline or kerosene, and thus saved. **The western lyctus,** *Lyctus cavicollis* Lec., is 2.5-3 mm. long, slender, a rusty brown species which mines the seasoned wood of eucalyptus, hickory, oak, orange, and so on, and is often destructive to furniture and building materials of these woods in California and Oregon. Attacks can be prevented by painting with hot linseed oil and waxing, or by varnishing. Infestations can be eliminated by fumigating, heating to 49° C., or dipping in kerosene. **The European lyctus,** *Lyctus linearis* (Goeze), is similar in size and color to the preceding and can be separated by the single row of large round shallow punctures on the elytra. It is a European species common in commercial

[1] E. J. Kraus and A. D. Hopkins, "Revision of Powder Post Beetles of the U. S. and Europe." *Tech. Ser.* No. 20, pt. 3, Bur. Ent. U. S. Dept. Agr. 1911.

A. D. Hopkins and T. E. Snyder, "Powder Post Damage by *Lyctus* Beetles to Seasoned Hardwood." *Farmers' Bul.*, 778, U. S. Dept. Agr. 1917.

products of ash, wild cherry, hickory, locust, oak, poplar, and walnut. In California it has been reared from dead grape canes and limbs of oaks, orange, and sycamore. **The southern lyctus,** *Lyctus planicollis* Lec.,[1] is 5 mm. long, slender, pitchy black, the elytra striate and with minute punctures in double rows. It mines hardwood commercial products and has been frequently introduced into the west from the Southern States, having been reported in Colorado, Arizona, California, Nevada, and Oregon.

LAMELLICORNIA (Series V)

KEY TO FAMILIES

1. Segments or lamellæ of the antennal club comb-like or pectinate and not capable of being closely coadapted.......... 2
   Segments or lamellæ of the antennal club thin and leaf-like and capable of being closely coadapted; antennæ not elbowed; abdomen with 5 or 6 visible rigid or free ventral segments; elytra rough, smooth, hairy or scaly. Small to large robust dull or brightly colored, often metallic beetles. (June Beetles, Lamellicorn Beetles, Cockchafers, etc.).......... **Scarabæidæ**

2. Antennæ not elbowed but usually curved so as to appear elbowed; mentum deeply emarginate, the ligula large, corneous and filling the emargination; front of head with a short bent horn pointing forward; body pedunculate; elytra striate and glabrous. Large oblong shining brown or black beetles. (Horned Beetles.) **Passalidæ**
   Antennæ usually elbowed, rarely straight; mentum entire and usually completely covering the maxillæ; mandibles prominent and strongly developed in the males. Large smooth rough striate punctate black and brown beetles. (Stag Beetles.) (Including **Sinodendridæ**).......... **Lucanidæ** p. 447

SCARABÆIDÆ.[2] June Beetles, Lamellicorn Beetles, Cockchafers.

These are small to large robust, dull to brightly colored and metallic beetles, the antennæ of which terminate in an oval club composed of from 3–7 leaves or lamellæ. The larvæ or grubs are usually thick, wrinkly white, or yellow, somewhat hairy, enlarged posteriorly, usually in the form of a crescent, and with well developed legs. The adults and larvæ are nocturnal, variable in general habits, and feed on dung, carrion, and decayed and living vegetation. Some are among the most serious pests to native and cultivated plants, and are exceedingly difficult to control.

The carnifex beetle, *Phanæus carnifex* (Linn.), is 12–22 mm. in length, the thorax usually bright coppery, and the elytra green. It ranges from the Atlantic to the Rocky Mountains and into Colorado and New Mexico. In the latter State the adults damage ripening peaches, plums, and other fruits and also feed on the tassels of corn. This beetle normally breeds in dung.

[1] T. E. Snyder, "Egg and Manner of Oviposition of *Lyctus planicollis*." *Jour. Agr. Research*, 6, p. 273, 1916.

[2] G. H. Horne, Miscl. Articles. *Trans. Am. Ent. Soc.*, 3, p. 42, 1870; 5, p. 137, 1875; 15, p. 1, 1887.

F. Blanchard, "Species of *Canthon* and *Phanæus* of U. S. With Notes of Other Genera." *Trans. Am. Ent. Soc.*, 12, p. 163, 1885.

Chas. Schaeffer, "*Bradycinetus* and *Bolboceras* of N. A. and Notes on Other *Scarabæidæ*." *Trans. Am. Ent. Soc.*, 32, p. 249, 1906.

E. C. Van Dyke, "Western *Scarabæidæ*." *Bul. Brooklyn Ent. Soc.*, 13, p. 9, 1918.

The fimbriate June beetle, *Pleocoma*[1] *fimbriata* Lec. (Figs. 339, 340), is 25–27 mm. long, large, robust, shining brown, and densely clothed beneath with long fine hairs. The males are black and half as large. The clypeus extends in front in the form of a broad emarginate horn which is widest at the apex. The large whitish grubs live in the soil and feed on the roots of plants. The adults live in holes in the ground which are 1 inch in diameter and from 18 to 30 inches deep, usually in red soil of the Sierra foothills of California. The adults usually fly in the fall or winter after the first rains, and habitually emerge at dusk in a fine drizzling rain. This habit according to R. Hopping[2]

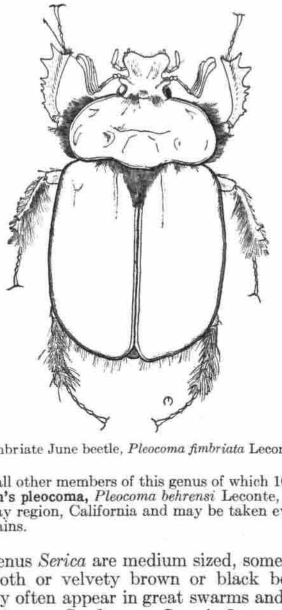

FIG. 339.—The fimbriate June beetle, *Pleocoma fimbriata* Leconte. Adult male.

is probably common to all other members of this genus of which 10 others are all western in distribution. **Behren's pleocoma,** *Pleocoma behrensi* Leconte, is the common species in the San Francisco Bay region, California and may be taken every fall during or just after the first soaking rains.

Members of the genus *Serica* are medium sized, somewhat cylindrical or robust, usually smooth or velvety brown or black beetles, with faintly striated elytra. They often appear in great swarms and do serious damage by defoliating fruit trees. *S. alternata* Lec. is 8 mm. long, and uniform shining brown in color. It is at times abundant and injurious to the foliage of avocado, peach, plum, prune, and other fruit trees in Southern California. **The manzanita serica,** *S. anthracina* Lec. (*C. crassata* Walk.) (Fig. 341), is 7.5 mm. long, and smooth dark brown or entirely black. It is common on the native shrubbery such as manzanita, oak, ceanothus, and lupines, in the foothill regions, and invades orchards in the spring,

[1] J. L. Leconte, "Notes on the Genus *Pleocoma*." *Trans. Am. Ent. Soc.*, 5, p. 81, 1874. G. H. Horn, "Revision of Species of *Pleocoma*." *Trans. Am. Ent. Soc.*, 15, p. 1, 1888.
[2] *Can. Ent.*, 52, p. 217, 1920.

often completely defoliating the apple, prune, plum, and other trees. It ranges in British Columbia, Washington, Oregon, and California. *S. fimbriata* Lec. is the largest of the common species, 9–10 mm. long, of a uniform orange, velvety brown, or rarely, with a grayish hue. It is com-

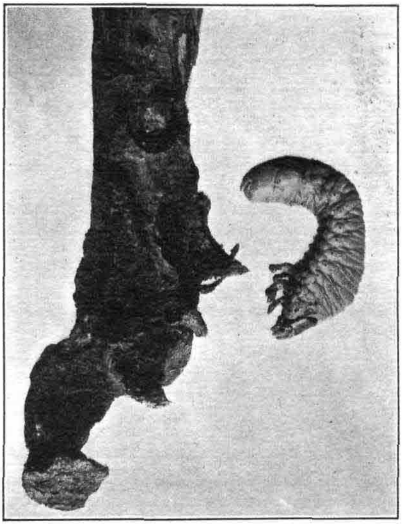

FIG. 340.—Larva of the fimbriate June beetle, *Pleocoma fimbriata* Lec., and work on the roots of a young pear tree. Somewhat reduced.

mon in Southern California and feeds on fruit trees and blackberry. *S. mixta* Lec. is similar in color but somewhat smaller and not velvety. It also occasionally defoliates deciduous fruit trees in Southern California. *S. serotina* Lec. is 8 mm. long, and pale to dull brown. It is often abundant in the Sacramento Valley, California, and has done serious damage to pear and other orchard trees.

Diplotaxis[1] *popino* Casey is 6–8 mm. in length, reddish brown or nearly black, and the upper surface clothed with many fine erect hairs. The adults at times defoliate apple, peach, rose, black walnuts, and pear. The green fruit is also devoured. It has also been taken on monkey flower and occurs in New Mexico and Arizona. *D. tenebrosa* Fall is 7.5–10 mm. long, robust, black, the elytra covered with minute reticu-

[1] H. C. Fall, "Rev. Species of *Diplotaxis* of U. S." *Trans. Am. Ent. Soc.*, 35, p. 1, 1909.

lations. It is common in British Columbia, Washington, Montana, Oregon, California, Nevada, Utah, and probably other Western States, and has been observed by R. C. Treherne to injure young apricot seedlings in British Columbia.

The members of the very large genus, *Phyllophaga* (*Lachnosterna*),[1] are large species commonly known as June beetles and are among the most destructive insects. The white grubs feed on the roots while the adults strip the leaves and fruit of many plants. Although very numerous in the east and middlewest, they are comparatively rare west of the Rocky Mountains. **The common June beetle,** *Phyllophaga fusca* (Frœlich), is 17–24 mm. long, oblong, shining brown or blackish, and one of the most widely distributed American species, reported in Colorado, Utah, Idaho, Nevada, Northern California, Oregon, Washington, and British Columbia in the west. It is often destructive to many plants and the adults often congregate about electric lights at night. They feed on ash, walnut, hazel, gooseberry, poplar, elm, blackberry, apple, hickory, willow, and oak. *P. rugosa* (Melsh.) is 18–22 mm. in length, and is a brown, reddish

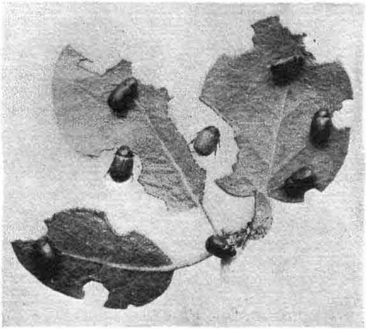

FIG. 341.—The manzanita serica, *Serica anthracina* Lec., and work on manzanita leaves.

brown, or blackish species. The adults commonly occur on poplars, willows, oak, blackberry, and elm. This species ranges west into Colorado and Montana where the larvæ have been noted as injurious to sugar beets. *P. errans* (Lec.) (Fig. 342) is 15–19 mm. long, oval-oblong, moderately robust, and shining brown. It is the commonest species along the Pacific Coast in British Columbia, Washington, Oregon, California, and Nevada. *P. lanceolata* (Say)[2] is 13–17 mm. long, brownish to nearly black, the surface alutaceous and sparsely clothed with whitish or yellowish scales. It is a Rocky Mountain species and occurs in the Western States of Colorado and New Mexico. Hayes lists a great many weeds, vegetables, field and forage crops, fruit trees, and native shrubs as food plants. The larvæ are serious pests to grasses and wheat. Clean culture for a series of years affords some control.

Phytalus pallidus Horn is 14 mm. long and dull brown with the elytra paler. It is distinguished from the above species by having the tips of the claws cleft. The larvæ

[1] Geo. H. Horn, "Rev. of Species of *Lachnosterna* of America No. of Mexico." *Trans. Am. Ent. Soc.*, 14, p. 209, 1887.

J. J. Davis, "Common White Grubs." *Farmers' Bul.* 543, U. S. Dept. Agr. 1913.

S. A. Forbes, *A General Survey of May Beetles of Illinois*. Bul. 186, Ill. Agr. Exp. Sta. 1916.

[2] W. P. Hayes, Life Cycle. *Jour. Econ. Ent.*, 12, p. 109, 1919.

eat the roots of native plants, fruit trees, strawberries, and roses. The adults appear at night and strip the leaves from roses and walnuts and the leaves and green fruit from peaches in Arizona.[1]

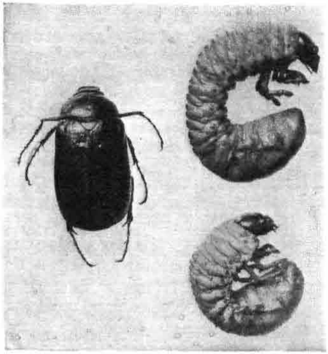

FIG. 342.—The California June beetle, *Phyllophaga errans* (Lec.). Adult and larvæ.

The ten-lined June beetle, *Polyphylla decimlineata* (Say), measures 25–35 mm., is robust, brown, the dorsum covered with yellowish and pure white scales, the latter arranged in two short longitudinal stripes on the head, three on the pronotum, and four long and one very short stripe on each elytron. The thorax beneath is clothed with long brownish hairs. The larvæ are large whitish grubs 25–50 mm. long. This is chiefly a Rocky Mountain species occurring in the Rocky Mountain States and in the southwest, and replaced along the Pacific Coast from Southern California into British Columbia by a similar species, *P. crinita* Lec. (Fig. 343), which is distinguished by having moderately long and erect hairs on the dorsum of the head and prothorax, and very few scales. The larvæ feed on the roots of shrubs and trees, often completely girdling or destroying them. Ornamental shrubs

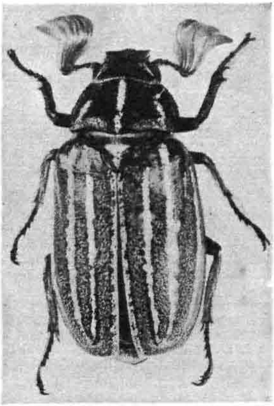

FIG. 343.—The coast lined June beetle, *Polyphylla crinita* Lec. Adult male. (Photo furnished by E. C. Van Dyke.)

[1] A. W. Morrill, *Sixth Ann. Rept.*, Ariz. Com. Agr. & Hort., p. 30, 1914.

and deciduous fruit nursery trees are also attacked. In the southern part of California the writer took the larvæ of the latter June beetle in sandy soil where they had completely barked and eaten off the main roots of cherry, California privet, black locust, and wisteria. During the winter there were series of three distinct sizes of the grubs indicating a three-year life cycle. The adults issue in the spring and summer and often appear in large numbers on warm evenings and fly low over the fields. They are also attracted to lights.

Crotch's green pine chafer, *Dichelonyx crotchi* (Horn) (*Dichelonycha*),[1] is 9 mm. long, slender, reddish black, and the elytra bright metallic green. It infests pines at high altitudes in British Columbia, Washington, Oregon, California, Nevada, Utah, and Montana. *D. decolorata* (Fall) is 9–11 mm. long, the venter, head, thorax, suture, and lateral stripe on the elytra black, and elytra pale brownish. It infests Monterey pines in the natural growths in California. *D. robusta* (Fall) is 7–9.5 mm. long, black, with the elytra metallic dark green. It has been taken in large numbers feeding on bunch grass on Mt. Hamilton, California in June by the writer, and also occurs in Oregon. *D. testaceipennis* (Fall) is black, the elytra testaceous in both sexes. It occurs on scrub oak, balsam pine, wild rose, and willow at high altitudes in New Mexico. *D. truncata* Lec. is a small dark reddish black species with bronze elytra which are punctured and coarsely wrinkled. It infests pines at high altitudes in every Western State. *D. valida* (Lec.) is dull brown, the elytra brilliant metallic green, the head, thorax, and venter of the male black and of the female red. The adults appear in April and May and feed on redwood in California. The species ranges into Oregon. *D. vicina* (Fall) is 9.5–13 mm. in length, black or reddish, with brilliant green elytra. It feeds on Douglas fir and ranges in the higher altitudes from California into British Columbia.

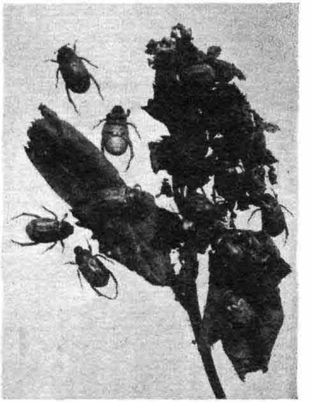

FIG. 344.—The pubescent hoplia, ***Hoplia pubicollis*** Lec., clustering on blackberry.

The hairy June beetle, *Phobetus comatus* Lec., is 13 mm. long, robust, pale amber-brown, the head, elytra, and abdomen somewhat darker, and the pronotum pale with a brown spot on each side. The pronotum and venter of the prothorax are clothed with long fine hairs. The adults appear in April and May and feed on the foliage of apple, peach, pear, and other fruit trees in many parts of California. The beetle ranges north into British Columbia. **The social June beetle,** *Cænonycha socialis* Horn, is 10–12.5 mm. long, light brown, the head and pronotum darker brown, or the entire body dark brown. The antennæ are 9-jointed and the true wings are rudimentary. It is an arid species sometimes injurious to apricot, plum, and other fruit trees in Southern California. Tin or cotton bands prevent it from ascending the trees.

[1] Geo. H. Horn, "*Dichelonycha*, Desc. and Keys." *Trans. Am. Ent. Soc.*, 5, p. 185, 1876.

H. C. Fall, "Notes on *Dichelonycha* and Keys." *Trans. Am. Ent. Soc.*, 27, p. 277, 1901.

The western rose chafer, *Macrodactylus uniformis* Horn, is 10 mm. long, a rather slender, long-legged, yellowish brown species greatly resembling **the rose chafer,** *M. subspinosus* (Fabr.), but has denser and longer pubescence on the elytra. It occurs in Arizona and New Mexico, while the latter extends westward into Colorado. The habits are also similar. The western form is injurious to apple, apricot, grape, pear, plum, and other fruit trees, roses, and various ornamentals, truck and field crops, and willow and other native shrubs. A spray composed of 1 gallon of blackstrap molasses, 6 pounds of arsenate of lead, and 100 gallons of water is effective as a control measure.

The cockchafers of the genus *Hoplia* (Fig. 344), are rather small, robust species, usually flat dorsally, covered with silvery scales ventrally, and the claws of the hind legs simple. The important species are best distinguished by the following key:

1. Scales on the dorsum light or grayish. 2
   Scales on the dorsum brightly colored, yellowish or greenish and black, 7 mm. California, Nevada. . . . . *H. dispar* Lec.

2. Hair short and stiff and longer on the pronotum than on the elytra. 3
   Hair rather long and silky and about the same length over the entire dorsum. Scales on elytra mottled various shades of brown, 7 mm. California. . . . . *H. callipyge* Lec.

3. Hair on elytra very short and inconspicuous, little or none on the pygidium. Elytra reddish brown. 8–8.5 mm. California. . . . . *H. sackeni* Lec.
   Hair on elytra quite abundant, thick and long on the pygidium. Elytra uniform or mottled brown. California, Oregon. . . . . *H. pubicollis* Lec.

The grapevine hoplia, *Hoplia callipyge* Lec., appears along the western Sierra foothills in the spring and devours the blossoms, young leaves, and fruit of grapes, peaches, and almonds, and also the flowers of ceanothus, greasewood, calla lilly, California poppy, magnolia, lupine, olive, orange, roses, and willow, and the leaves of beans, horse beans, peas, and vetches. It can be controlled by hand picking or spraying, as recommended for the rose chafers.

The pubescent hoplia, *Hoplia pubicollis* Lec. (Fig. 344), ranges along the Sierra foothills of California and the Cascades of Oregon. It has similar habits to the preceding species and is common in azalea flowers.

The silver beetle, *Plusiotis gloriosa* Lec., is 30 mm. long, bright emerald green, with longitudinal silver stripes on the elytra. It feeds on the silver tipped western juniper at high altitudes in Arizona. *P. beyeri* Skinner is 25–28 mm. long, glossy pea green, with green legs and violet tarsi. It feeds on the leaves of Emory oak in Arizona and also occurs in Texas. *Plusiotina lecontei* (Horn) (*Plusiotis*) is 20–23 mm. in length, brilliant emerald green above, and the venter with a coppery lustre. It feeds on the leaves of oak and black walnut in Arizona and New Mexico.

The mayate, *Cotalpa*[1] *consobrina* Horn, measures 20–23 mm., is elongated, uniform yellow, glabrous, and the thorax finely punctured. The adults appear with the first rains in June and July, and strip the leaves of the cottonwood trees at night in Arizona. According to A. W. Morrill,[2] they begin at the ends of the highest branches and work

[1] G. H. Horn, Key to Species. *Trans. Am. Ent. Soc.*, 3, p. 338, 1870.
H. F. Wickham, Key to N. A. Species. *Jour. N. Y. Ent. Soc.*, 13, p. 1, 1905.
[2] *Sixth Ann. Rept.*, Ariz. Com. Agr. & Hort., p. 46, 1914.

downward. They also swarm about electric lights. **The western goldsmith beetle,** *C. tau* Wickham, is 20–26 mm. long, metallic yellowish, the pronotum brownish at the sides, and the brown elytral sutural stripe forms a letter "T" on the back. It often completely defoliates cottonwood trees near the edges of the desert in Arizona. *C. subcribrata* Wickham is 17–20 mm. long, robust, yellowish above, the head, pronotum, and scutellum metallic greenish, the venter dark green, somewhat metallic, and legs yellow. It feeds on willow and occurs in Colorado and Kansas.

The little bear, *Pocalta ursina* (Horn) (*Cotalpa*), is 23 mm. in length, robust, metallic steel blue or bluish or greenish black, the pronotum deeply punctured, the elytra reddish brown, and the body clothed with long yellowish hairs. It flies on dull days and often appears in large numbers in Southern and Lower California.

The desert June beetle, *Ochrosidia villosa* (Burmeister) (*Cyclocephala*),[1] is 11–14 mm. long, pale yellow to dull brown or amber, and sparsely clothed with fine hairs. The adults fly at night and are attracted to lights. They feed on pigweed. The larvæ feed on the roots of grasses, corn, wheat, oats, barley, and strawberry. It is primarily an arid or desert species occurring in California and Arizona. *Dichromina dimidiata* (Burm.) (*Cyclocephala*) [2] is a similar species ranging in New Mexico, Arizona, and Southern California. The adults are nocturnal and often occur in the flowers of Jimpson weed. They also defoliate and eat the green fruit of peaches and other fruit trees, and strip the leaves of roses and walnuts. The larvæ attack the roots of grasses, strawberry plants, and young fruit trees.

The muck or carrot beetle, *Ligyrus gibbosus* (De Geer) [3] (Fig. 345), is 14- to 16 mm. long, robust, shining, uniform reddish brown, with rather long hair on the venter. The eggs are pure white, smooth, almost globular, 1.5 x 1.8 mm., and laid in early spring in the soil near the host plants or in rich humus. They hatch in from 1 to 3 weeks. The larvæ are white, often with a bluish tinge, and with brown head and spiracles. When mature they are 31 mm. long. They are very general feeders and attack the roots of grasses, barley, corn, oats, wheat and other cereals, pigweed, wild sunflower, and many other plants, and when hard pressed are cannibalistic. The adults work both below and above ground and infest beets, carrots, celery, corn, cotton, dahlias, elm, oak, parsnip, potatoes, ragweed, and wild and cultivated sunflowers. The species is widely distributed throughout North America and occurs in most of the Western States. *Oxygrylius ruginasus* (Lec.) (*Ligyrus*) is a similar species varying from pale yellow to reddish. The adults have been reported as eating off the roots of lettuce and doing considerable damage to that crop in Idaho. The species occurs also in Texas, New Mexico, and probably other Western States.

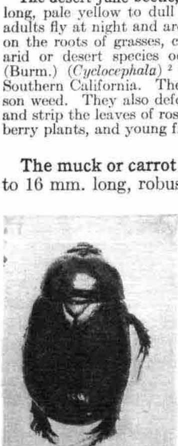

Fig. 345.—The muck or carrot beetle, *Ligyrus gibbosus* (De Geer).

The green fruit or peach beetle, *Cotinis texana* Casey (*Allorhina mutabilis* G. & P.), is 20–34 mm. in length, robust, widest at the bases of the elytra, flat on dorsum, usually opaque green above, but it may vary from green and coppery to violet. It is a Central American and Mexican species which

[1] W. P. Hayes, *Jour. Econ. Ent.*, 11, p. 136, 1918.
[2] A. W. Morrill, *Sixth Ann. Rept.*, Ariz. Com. Agr. & Hort., p. 30, 1914.
[3] W. P. Hayes, *Jour. Econ. Ent.*, 10, p. 253, 1917.

ranges north into Texas, New Mexico, and Arizona, and has a distinct liking for ripe peaches, but also freely eats apricots, apples, figs, grapes, muskmelons, nectarines, pears, tomatoes, and the fruit of cacti. The larvæ breed in the dung of old corrals.

The bumble flower beetle, *Euphoria inda* (Linn.), is 13–16 mm. long, broadly oval, and yellowish brown above, mottled with black spots. The venter is dark and densely hairy. The adults appear with the first warm spring days and feed on the ears of corn, apples, grapes, peaches, and other fruits. The larvæ breed in dung, rotten wood, and humus. It is a common eastern species which ranges west into Montana, Idaho, Colorado, and New Mexico.

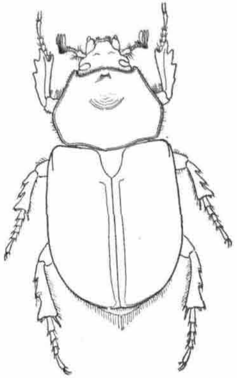

FIG. 346.—*Strategus julianus* Burmeister var. *arizonicus* Schæffer, an Arizona species.

LUCANIDÆ.[1] Stag Beetles.

The cottonwood stag beetle, *Pseudolucanus mazama* (Lec.) (*Dorcus, Lucanus*), is 24–32 mm. long, smooth brown, the femora black, the head not broader than the prothorax, and the elytra finely punctured. It breeds in dead cottonwood in New Mexico, Arizona, and Utah. **The aspen stag beetle,** *Platycerus depressus* Lec., is 13 mm. long, black, and infests dead aspen in New Mexico, Colorado, Arizona, California, and other parts of North America. **The oak stag beetle,** *P. agassizi* Lec., is 10 mm. in length, black, the elytra striate and punctured, and the interspaces rugose. It breeds in dead madrona, live oak and tanbark oak in California.

FIG. 347.—The rugose stag beetle, *Sinodendron rugosum* Mann. A, males; B, female; larvæ at right.

The incense cedar stag beetle, *P. latus* Fall, is 9–11 mm. long, stout, shining, nearly black, and infests dead incense cedar in the Sierras of

[1] Chas. Fuchs, "Syn. *Lucanidæ* of U. S." *Bul. Brooklyn Ent. Soc.*, 5, p. 49, 1882.

California. **The Oregon stag beetle,** *P. oregonensis* Westw., is 13 mm., dark bluish, the elytra punctured in rows, not rugose. It breeds in dead alder, California laurel, madrona, and so on, in California, Oregon, and into British Columbia. The adults fly in the heat of the day. **The rugose stag beetle,** *Sinodendron rugosum* Mann. (Fig. 347), is 11–18 mm. long, cylindrical, the head much narrower than the prothorax, shining, black, rugose, with a short horn on the head which curves backwards and which is much more prominent on the male than on the female. The larvæ feed in wet, dead, and rotting alder, California laurel, oaks, and willow, in California, Oregon, Washington, and British Columbia.

PHYTOPHAGA (Series V)

KEY TO FAMILIES

1. Mentum pedunculate; front prolonged into a broad quadrate beak; antennæ short, serrate or pectinate, inserted in front of the eyes; prosternum very short; hind femora usually thickened; body short, more or less oval, tip of the abdomen exposed. Small robust seed infesting beetles. (Pea and Bean Weevils). (*Bruchidæ, Lariidæ*) **Mylabridæ** p. 482
   Mentum not pedunculate.......... 2

2. Body short and somewhat oval; antennæ short or not greatly lengthened and not inserted on frontal prominences; front small, oblique or inflexed; thorax frequently margined, tibial spurs usually absent. Minute to small oval dull or brightly colored, smooth, hairy or scaly plant-eating beetles. (Leaf Beetles.). **Chrysomelidæ** p. 463
   Body elongate; antennæ usually long and often greatly lengthened and frequently inserted on frontal prominences; front often large, vertical and quadrate; thorax rarely margined; tibial spurs distinct. Medium to large slender or cylindrical dull or brightly colored, smooth, punctate, hairy or scaly wood-boring beetles. The adults frequent flowers. (The Long-horned Beetles.) .... **Cerambycidæ**

CERAMBYCIDÆ.[1] Long-horned Beetles.

This family consists of mostly large, slender, wood-boring beetles, usually with very long antennæ. The adults commonly visit flowers. The larvæ are somewhat cylindrical and are often referred to as round-headed borers. They mine normal, injured, dying and dead wood, and often do serious damage to forest, shade, fruit, and ornamental trees and shrubs.

The pine sawyer, *Ergates spiculatus* Lec. (*E. californicus* White, *E. neomexicanus* Casey), is a large, slender, dark brown beetle, 40–58 mm. long. The head and prothorax are granulate above and darker than the

[1] J. L. Leconte, "An Attempt to Classify Longicorn *Coleoptera* of N. A." *Jour. Phila. Acad. Nat. Sci.*, p. 311, 1850; 2, p. 5, 1851; pp. 99, 139, 1852.
C. W. Leng, "Synopses of *Cerambycidæ*." *Bul. Brooklyn Ent. Soc.*, 7, p. 57, 1884–85.
C. W. Leng and John Hamilton, "The *Lamiinæ* of N. A." *Trans. Am. Ent. Soc.*, 23, p. 101, 1896.
W. H. Harrington, "List of *Cerambycidæ* of British Columbia." *Can. Ent.*, 31, p. 107, 1899.
J. L. Webb, "A Preliminary Synopsis of Cerambycoid Larvæ. *Tech. Ser.*, 20, pt. 5, Bur. Ent. U. S. Dept. Agr. 1912.
F. C. Craighead, "Larvæ of the *Prioninæ*." *Rept.* 107, Office of Secy., U. S. Dept. Agr. 1915. "Hopkins Host-Selection Principle as Related to Certain Cerambycid Beetles." *Jour. Agr. Research*, 22, p. 189, 1921.
R. T. Garnett, "Annotated List of *Cerambycidæ* of California." *Can. Ent.*, 5, pp. 172, 205, 248, 281, 1918.

elytra. The prothorax has the lateral margin armed with a few large and many very small, sharp teeth or spines; the elytra are minutely granular with a few vittæ. The eggs are laid in the crevices of the bark of dead pine,

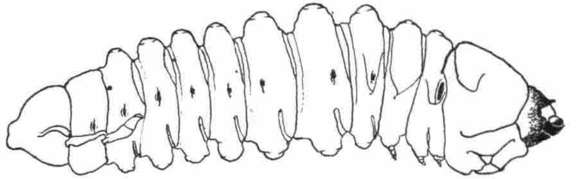

FIG. 348.—Larva of the pine sawyer, *Ergates spiculatus* Leconte.

and the larvæ (Fig. 348) excavate large burrows in the sapwood and heartwood of the trees. They mature in two or three years and are creamy white and 50–60 mm. long. They are usually found in wood which has been dead for more than one year or which is very old, and attack the roots, stumps, fallen logs, and standing trees of yellow pine, Monterey pine, and other coniferous trees. They are more abundant at altitudes above 4,000 feet. The adults are often attracted to lights. The species is common in New Mexico, Colorado, Arizona, California, Nevada, Oregon, Washington, British Columbia, and probably other Western States.

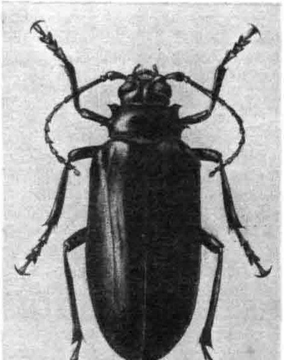

FIG. 349.—The California prionus, *Prionus californicus* Mots. Adult. (Drawing by G. F. Mozenette.)

The California prionus, *Prionus californicus* Mots. (Figs. 349, 350), is 40–60 mm. long, shining, uniform dark reddish brown, somewhat like the preceding, but usually with 3 sharp teeth on each lateral margin of the prothorax. The larvæ are very large, white grubs attaining a length of 60–75 mm. The species is very common along the Pacific Coast from Central California to Alaska and is also reported from Arizona, New Mexico, Colorado, and Nevada. The adults are nocturnal and fly in midsummer to fall. They are readily attracted to lights. The adults make a loud humming noise on the wing and often strike the windows at night with an impact that almost breaks them. The larvæ probably breed normally in dead and decaying roots and stumps of live and deciduous oaks, but readily attack living and

FIG. 350.—Larvæ of the California prionus, *Prionus californicus* Mots., and work on roots of young cherry tree.

dead roots of alder, almond, cherry, cottonwood, eucalyptus, madrona, orange, peach, plum, poplar, prune, English and black walnut, and frequently kill fruit and native trees. *P. heroicus* Semen. (*P. heros* Fall) is 40–48 mm. long, nearly black, and more robust than the preceding species, with the marginal prothoracic teeth less sharp. It ranges in New Mexico, Arizona, Colorado, and may replace the former in those States.

Harris' pine borer, *Tragosoma depsarium* (Linn.) (*T. harrisi* Lec., *T. spiculum* Casey), is 30–33 mm. in length, shining brown, the lateral margins of the very hairy prothorax with a single sharp median tooth. The larvæ breed in dead stumps, logs, and standing yellow, lodgepole or tamarack, and other pines throughout the northern parts of North America. This species occurs in the mountains of New Mexico, Colorado, Utah, Nevada, California, Oregon, Washington, and British Columbia in the west.

The black spruce borer, *Asemum atrum* Esch., is a small, slender, dull black beetle, 12 mm. long, with relatively short antennæ, and a few prominent striæ on the elytra. It is reported in New Mexico, Colorado, Utah, Nevada, California, Washington, and British Columbia. The larvæ commonly mine the bark and sapwood of living, injured, and dead Douglas fir and Jeffrey pine. They are preyed on by the colydid beetle, *Deretaphrus oregonensis* Horn.[1] **The Douglas fir borer,** *Liasemum nitidum* (Lec.) (*Asemum*), is 13–16 mm. long, brown or black, and very similar to the preceding. The larvæ make transverse and winding galleries in the bark of normal, injured, declining, and dead Douglas fir, Monterey and other pines, and mountain hemlock. This borer is a common enemy of Douglas fir, and healthy trees are often killed by successive attacks. It occurs in the higher mountains of California, Nevada, Oregon, and Washington.

The Sierra fir borer, *Tetropium abietis* Fall, is 13–17 mm. in length, uniform pale to dark brown. The larvæ mine the bark and sapwood of normal, injured, dying and dead white fir and red fir, and are particularly destructive to the former. The species occurs in the Sierras of California. **The western larch bark borer,** *T. velutinum* Lec., measures 9–19 mm., and is a brown or black-

[1] F. C. Craighead, *Proc. Ent. Soc. Wash.*, 22, p. 8, 1920.

ish beetle which is an important pest to lodgepole and other pines, and to Douglas fir in Northern California, Oregon, Washington, British Columbia, and Montana.

Criocephalus asperatus Lec. is 20–27 mm. long, slender, dark brown, or almost black. The larvæ commonly mine dead fir and spruce in New Mexico, California, Nevada, Oregon, Washington, Montana, and British Columbia. It is a very common species about lights at Berkeley, California, and must come from pines inasmuch as there are few or no firs or spruce trees in the district, while there are many Monterey and other pines. *C. productus* Lec. is 18–22 mm. long, much smaller than the former, and has similar habits. The larvæ attack dead pine and Douglas fir in New Mexico, Colorado, California, Oregon, Washington, and British Columbia. *Opsimus quadrilineatus* Mann. is 9–12 mm. long, variable in color but usually dark brown, and has 4 ridges on each elytron. It breeds in Douglas fir and Sitka spruce, and occurs from California to Alaska. *Œme gracilis* Lec. is 12 mm. long, deep brown, the thorax oval and narrowest at the base. It commonly breeds in dead coast live oak in California.

The ribbed pine borer, *Rhagium lineatum* Olivier (Fig. 351), is 13–18 mm. in length, gray, marked with black on the dorsum, the elytra widest at the base, strongly ribbed, and with black, whitish, and rusty or orange

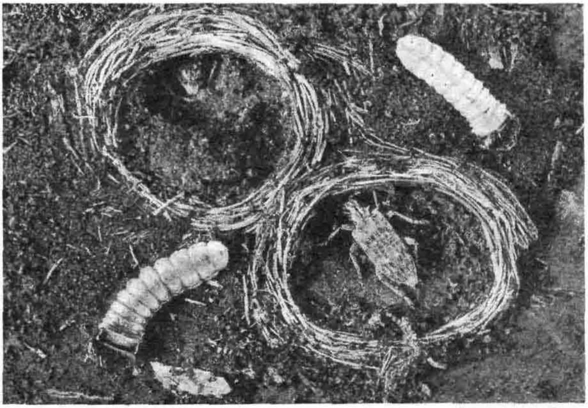

FIG. 351.—The ribbed pine borer, *Rhagium lineatum* Olivier. Larvæ, adults and pupal cells on the inside of the dead bark of digger pine. The adult at the top is burrowing through the bark preparatory to emerging.

spots. The head and prothorax are nearly equal in width and only about half as wide as the elytra, the prothorax with a large tooth at the middle of each side. The large white larvæ are 25–30 mm. long when mature. They mine the bark and sapwood of dead digger, Jeffrey, Monterey, yellow, and other pines. Maturity is reached in February and March and the larvæ construct a very interesting shallow circular cell between the bark and the sapwood in which to pupate. The cell is particularly interesting because of its striking resemblance to a bird's nest due to the

long string-like pieces of white sapwood entwined and held together in an outer ring by dark frass. From this cell the adults emerge through a large elongated hole in March and April. The species occurs throughout North America and is common in New Mexico, Colorado, California, Nevada, Oregon, Washington, British Columbia, Alaska, and probably all of the Western States.

The yellow Douglas fir borer, *Parapachyta spurca* (Lec.) (*Pachyta*), is a large yellowish brown beetle 20–26 mm. long, similar in shape to the preceding borer, with a more elongated thorax armed with a short spine on each side. The larvæ mine dead Douglas fir in California, Nevada, Oregon, Washington, and British Columbia. *Pachyta liturata* Kirby (Fig. 352) is smaller but much broader across the base of the elytra and

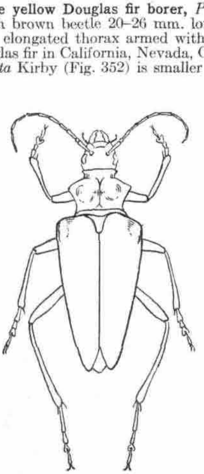

FIG. 352.—*Pachyta liturata* Kirby.

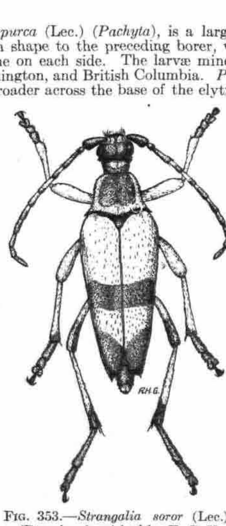

FIG. 353.—*Strangalia soror* (Lec.). (Drawing furnished by E. C. Van Dyke.)

varies from straw to black in color. It mines dead firs and Douglas fir in the high mountains of practically every Western State, and ranges north into Alaska.

The redwood borer, *Judolia impura* (Lec.) (*Leptura*), mines the sapwood of dead redwood in California and other conifers in Nevada and Oregon. *J. sexmaculata* (Linn.) (*Leptura*), is 12 mm. long, black, the elytra yellowish with three black areas on each. It breeds in Douglas fir in Northern California and Oregon. The species occurs in Europe, Siberia, and throughout boreal North America. *Parallelina subargentata* (Kirby) (*Leptura*), is 6–7.5 mm. in length, dull black with fine white pubescence, the legs and antennæ sometimes reddish. The varieties may be partly red. The species occurs throughout much of North America and in every Western State. It breeds in tanbark and other oaks. *Strangalia barberi* (Fall) (*Leptura*) is 8–9 mm. long, entirely black, the head and pronotum punctate, and the elytra shining. It mines dead Sitka spruce in Northern California and probably extends northward along the Pacific Coast. *S. obliterata* (Hald.) (*Leptura*) is 16–18 mm. in length, dark brown, the elytra pale with two basal spots, a median band, and an apical band or with the entire apex black. It breeds in sapwood of redwood, Douglas fir, and other conifers, and ranges from Northern California into British Columbia. *S. soror* (Lec.) (*Leptura*) (Fig. 353) is

12–18 mm. long, rather slender, black and pale yellowish brown, the head and pronotum mostly black, and the elytra pale with a median black band and black tips. It is common in the high Sierras of California and Nevada. The adults visit the flowers of the false hellebore and the larvæ breed in the dead branches of yellow pine. *Xestoleptura crassipes* (Lec.) (*Leptura*) (Fig. 354) is 8–12 mm. long, the head, thorax, and venter black, the remainder pale brown. The elytra of the male are largely brown with three or four broken transverse bands or spots, while those of the female are largely black, with base, a median marginal half circle, and a subapical spot, brown. The species breeds in California laurel and ranges from California and Nevada into British Columbia. *Strophiona læta* (Lec.) (*Leptura*) is 10–13 mm. long, somewhat shortened, beautiful, bright velvety yellow or golden, with a narrow black transverse band at the base and tips, and three wide black transverse bands across the elytra. It is a common species which breeds in live and other oaks in California, Nevada, and north into British Columbia.

The yellow velvet beetle, *Leptura chrysocoma* Kirby, is a beautiful velvety yellow or golden species, 9–15 mm. long, which is a common flower visitor in the northern part of North America and in the higher mountains of the west, being taken frequently in the Sierras of California and Nevada. It has been reared from dead alder in California. *L. brevicornis* Lec. is a large, dull black species, 17 mm. in length, with the

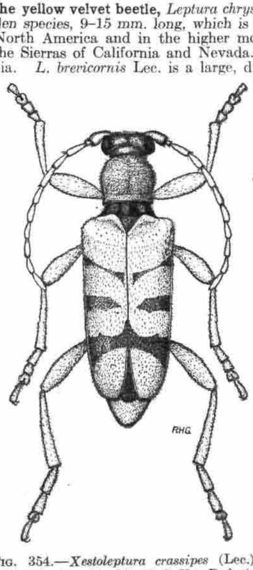

FIG. 354.—*Xestoleptura crassipes* (Lec.). (Drawing furnished by E. C. Van Dyke.)

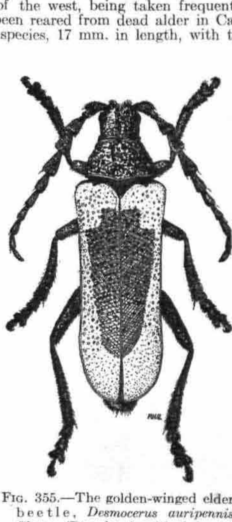

FIG. 355.—The golden-winged elder beetle, *Desmocerus auripennis* Chev. (Drawing furnished by E. C. Van Dyke.)

dorsum finely punctate. It has been reared from yellow pine, and occurs in Nevada, California, Oregon, and Washington. E. P. Van Duzee took a female from a white fir stump at Lake Tahoe, California. *L. grossa* Lec. also breeds in yellow pine in California. *L. matthewsi* Lec. is 12–14 mm. long, dull reddish brown, the elytra paler brown, with a median transverse, black, broken band, and the apices black. The median band may be reduced to a marginal spot on each side. It mines the dead sapwood of redwood, cedar, and similar conifers, and ranges along the Pacific Coast from Northern California into British Columbia. *L. insignis* Fall is 20–25 mm. long, red-

dish black, the elytra somewhat paler, each with two elongate marginal spots before the middle, a broad brown humeral stripe extending nearly to the apex, and a short subbasal stripe. It breeds in dead Douglas fir, Monterey pine, and Bishop pine along the middle California Coast. *Pyrotrichus vitticollis* Lec. is 10 mm. in length, black, and the thorax margined yellow. It enters old wounds and may kill old trees. The larvæ work into the heartwood of alder, California laurel, and poplar, in California.

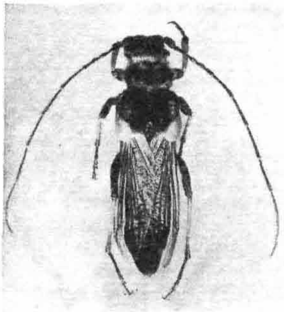

FIG. 356.—The lion beetle, *Ulochætes leoninus* Leconte.

The golden-winged elder borer, *Desmocerus auripennis* Chev. (Fig. 355), is 23–28 mm. long, black with bluish reflections, the dorsum coarsely punctured, and the posterior margins of the prothorax terminating in a small tooth. The elytra of the male are entirely golden orange, while those of the female are orange with a large elongated blue-green or blue-black median blotch of variable size. The larvæ live two years and mine the trunks and limbs of living blue elderberry in the high Sierras of California and Nevada. *D. californicus* Horn has the elytra of the male bluish or purplish with orange margins and those of the female black or slaty with very narrow orange margins. The larvæ enter wounds and scars, and mine into the pith of living blue elderberry and red elderberry in California. Limbs and smaller branches may be killed by their attacks. *D. cribripennis* Horn has the elytra of both males and females dark

FIG. 357.—The California laurel borer, *Rosalia funebris* Mots. Male at right.

green with orange margins. The adults fly in April and May. The larvæ mine the pith of red elderberry in California, Oregon, and Washington. They seldom kill the branches. *D. piperi* Webb is 15–20 mm. long, black, the elytra of the male

entirely orange and those of the female blue-green with narrow orange margins. It mines the stems of the blue elderberry in Oregon, Washington, British Columbia, and Idaho.

The lion beetle, *Ulochætes leoninus* Lec. (Fig. 356), is 20–26 mm. long and looks as much like a bumblebee as it does a beetle, as it is black with the pronotum densely covered with yellow pile and the very short or abortive elytra tipped with yellow. The wings are almost fully exposed and extend slightly beyond the tip of the abdomen which is usually turned up. The larvæ breed in yellow pine, Jeffrey pine, alpine hemlock, white fir, and Douglas fir in the higher mountains of California, Oregon, Washington, and British Columbia.

The California laurel borer, *Rosalia funebris* Mots. (Fig 357), is 25–38 mm. long, beautifully marked black and pale blue as illustrated. The larvæ commonly mine dead California laurel, Oregon ash, and willow in New Mexico, California, Oregon, Washington, British Columbia, and Alaska.

Semanotus lignea (Fabr.) (*Hylotrupes*) is 7–17 mm. in length, black, finely hairy, the elytra red or yellow with a dusky basal black blotch, two oval black spots, and black tips. It has been reared from redwood, Douglas fir, and Monterey pine in California and occurs in Oregon, Washington, British Columbia, Colorado, Arizona, and many other parts of North America. *Semanotus nicolas* White (*Anacomis litigiosa* Casey) infests fir in the higher mountains of California, Oregon, Washington, and Idaho. **The western cedar bark borer,** *Semanotus amethystinum* (Lec.) (*Hylotrupes*), is 25–38 mm. long, black, with violet or bright blue elytra. The larvæ are of medium size and mature in one year. They excavate broad winding burrows in the living bark, sapwood, and heartwood of injured, dying, and recently felled western red cedar, incense cedar, and yellow pine in Arizona, California, Oregon, Washington, and British Columbia. *S. juniperi* (Fisher) (*Callidium*) is 10 mm. long, shining black beneath and greenish dark blue above. It occurs under the bark of cedar in New Mexico. *S. cupressi* Van Dyke,[1] is 9 mm. in length, rufous, the tarsi, tibiæ, and bases of the femora black, and the elytra dark blue. It breeds in the dying twigs of Sargent cypress in Marin County, California. *Callidium antennatum* Newn. (Fig. 358) is 9–12 mm. long, flattened, with very long antennæ, and of a brilliant blue or green color. It infests the inner bark and sapwood of the smaller limbs of Douglas fir, spruce, pine, and most coniferous trees in California, Nevada, Oregon, Idaho, and ranges east to the Atlantic. *C. californicum* Casey is a species closely resembling this, but smaller and with shorter antennæ. It attacks junipers and cedar in Oregon, California, and Nevada. *C. hirtellum* Lec. infests yellow pine in New Mexico, Colorado, and the Sierras of California. *C. pseudotsuga* Fisher measures 10–13 mm. and is dull black. It infests the wood of freshly cut branches of Douglas fir in California and Oregon. *C. sequarium* Fisher is 11–12 mm. long, and black throughout. It infests the sapwood of the limbs of dead, fallen giant sequoia in the Sierras of California. *Phymatodes blandus* Lec. is 5–6 mm. long, and orange yellow with metallic blue or purple elytra. It breeds in the canes of wild grape in Cali-

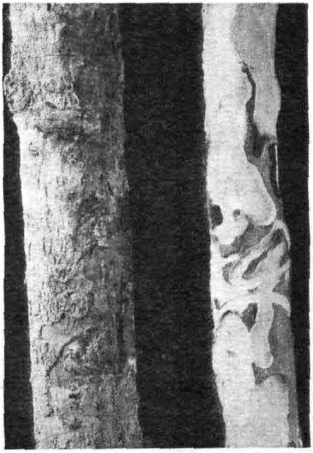

FIG. 358.—Work of the larvæ of *Callidium antennatum* Newm. on the limbs of Douglas fir. Adult beetle on bark at left.

[1] E. C. Van Dyke, *Bul. Brooklyn Ent. Soc.*, 18, p. 48, 1923.

fornia. *P. fasciapilosus* Van Dyke [1] is 7 mm. in length, blackish, the antennæ and bases of the elytra reddish. It breeds in wild grape in Oregon. *P. decussatus* Lec. is 5–6 mm. long, shining dark mahogany brown, with two oblique silver stripes on each elytron. It infests valley, Engelmann, and other oaks in California, and ranges north into British Columbia. *P. dimidiatus* (Kirby) is 12–13 mm. long, dull dark brown with an orange band near the base of the elytra. It breeds on Douglas fir in New Mexico, Colorado, Wyoming, Montana, Idaho, Washington, British Columbia, Alaska, Oregon, California, and ranges eastward to the Atlantic. *P. æneus* Lec. is 6 mm. in length and dark bluish black. It also attacks Douglas fir in California, Oregon, Washington, British Columbia, and Alaska. *P. vulneratus* Lec. is 7 mm. long, head, thorax, and tips of the elytra dark brown, the base of the elytra reddish which color is separated from the dark brown by an oblique yellow band. Some are almost black with the yellow bands on the elytra. It infests the broad-leaved maple in California. *P. juglandis* Leng mines the sapwood of the California black walnut in Southern California. *P. nitidus* Lec. is 6–7 mm. long, shining dark blackish brown, with two conspicuous yellow oblique bands on each elytron. It mines dead wood of Monterey cypress, redwood, juniper, and related trees, and ranges from California into British Columbia. *P. obscurus* Lec. is 10–12 mm. in length, pale to dark reddish brown, with a violet lustre on the elytra. It breeds in the twigs of coast live oak, valley oak, tanbark oak, and other oaks in California.

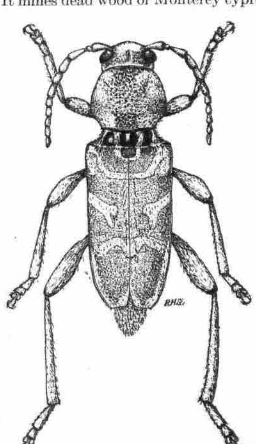

FIG. 359.—The nautical borer, *Xylotrechus nauticus* (Mann.). (Drawing furnished by E. C. Van Dyke.)

The black gooseberry borer, *Xylocrius agassizi* (Lec.), is 12 mm. long, dull black, and with a granulated surface. The larvæ tunnel the stems and roots of wild and cultivated gooseberries and have also been reared from willow in California, Oregon, and British Columbia. *X. cribratus* Lec. is similar in size and appearance but the posterior portions of the elytra are more coarsely punctured. It is quite abundant in the Sierras of California and Nevada where it breeds in the stems of wild gooseberry. The winter is spent in the canes, and the adults mature and emerge the following summer.

The round-headed mesquite borer, *Megacyllene antennatus* (White),[2] is 12–30 mm. long, brown, with gray scales on the pronotum, and two wide and two indistinct narrow transverse bands on the elytra. The larvæ are yellowish white and may attain a length of 40 mm., being the largest and most destructive grub found in recently cut and cured mesquite in Arizona and Southern California.

The locust borer, *Cyllene robiniæ* (Forster),[3] is a common and well known eastern insect which ranges west as far as the eastern slopes of the Rocky Mountains of Colorado. The adults are 14–18 mm. in length, slender, black, with narrow yellow bands across the dorsum, and wide broken yellow bands on the venter. The yellow markings on the elytra are zigzag and broken. The legs are reddish. The small elongated white eggs are laid in the crevices of the bark in the early fall and hatch in 8 to 10 days. The larvæ make winding burrows into the heartwood of the black

[1] E. C. Van Dyke, *Bul. Brooklyn Ent. Soc.*, 15, p. 33, 1920.
[2] F. C. Craighead, *Farmers' Bul.* 1197, 1921, p. 6.
[3] A. D. Hopkins, *Circ.* 83, Bur. Ent. U. S. Dept. Agr. 1907.
H. Garman, *Bul.* 200, Ky. Agr. Exp. Sta. 1916.
C. E. Sanborn and H. R. Painter, Bul. 113, Okla. Agr. Exp. Sta. 1917.

locust. They are white and when mature measure 18–20 mm. The winter is passed as larvæ. Pupation occurs in the burrows in July and August and the adults appear in August, September, and October. They commonly visit the goldenrod. Control consists in cutting out the infested limbs, and in spraying the trunks and larger limbs in the late fall with strong miscible oil or with 1 part of kerosene well agitated with two parts of water to kill the eggs.

The nautical borer, *Xylotrechus nauticus* (Mann.) (Figs. 359, 360, 361), is 8–15 mm. long, grayish brown or nearly black, with three transverse, zigzag white lines on the elytra and short antennæ. The white larvæ attain a length of 18 mm. and normally

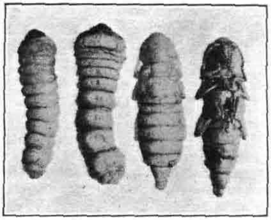

FIG. 360.—Larvæ and pupæ of the nautical borer, *Xylotrechus nauticus* (Mann.).

FIG. 361.—Branch of dead eucalyptus with bark removed to show burrows of the larva of the nautical borer, *Xylotrechus nauticus* (Mann.). (Photo by C. J. Pierson.)

live in the heartwood of dead oak, but also attack living or injured English walnut and peach, and dead eucalyptus and madrona. The species ranges in many parts of the west, but is reported only in California and Montana. *X. insignis* Lec. is 13–15 mm. in length, the males usually beautiful velvety reddish brown, with lines on the face, margins of the pronotum, the bases, apices, and a preapical transverse band on the elytra, yellow. The females are black with reddish antennæ and legs and with variable transverse yellow bands on the dorsum. This species breeds in willow in Oregon, Nevada, California, and Arizona. *X. obliteratus* Lec. is often a serious pest to aspen and other poplars in the higher altitudes of Colorado and Utah, and frequently kills the trees. *X. annosus* (Say) breeds in normal and injured poplars in the east and California. *X. undulatus* (Say) breeds in Douglas fir and yellow pine in New Mexico, California, and ranges north into British Columbia. *Neoclytus muricatulus* (Kirby) is 7–10 mm. long, black or brown with white markings, and breeds in Douglas fir in the higher mountains of New Mexico, Colorado, California, and ranges throughout boreal North America. *N. balteatus* Lec. breeds in manzanita, in California and Oregon. *N. conjunctus* (Lec.) (Fig. 362) breeds in madrona, manzanita, white oaks, and Oregon ash in California, Oregon, Washington, and British Columbia. *Clytus planifrons* Lec. is 9–12 mm. in length, dark brown or almost black with yellow lines on the face, a narrow bright yellow margin around the pronotum, bright yellow scutellum, and a basal, two median, and apical bands on the elytra. The second elytral band curves forward at the suture. This species breeds in dead branches of Douglas fir and true firs, and is common in the Sierras of California and Nevada and also occurs in Colorado, British Columbia, and probably many other Western States. *Atimia dorsalis* Lec. infests Monterey and Sargent cypress, juniper, and post cedar in California (Van Dyke) and Alaska or yellow

cypress in Oregon. *Holopleura marginata* Lec. (*H. helena* Lec.) (Fig. 363) is 7–10 mm. long, black, the dorsum bright red with small black spots on the pronotum, and

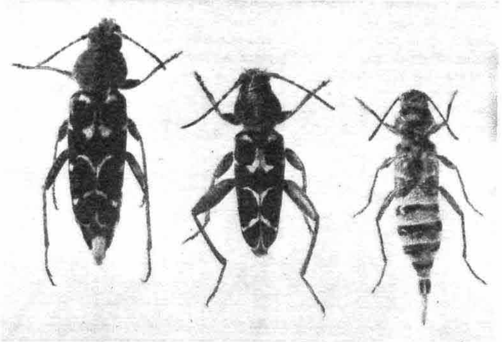

FIG. 362.—*Neoclytus conjunctus* (Leconte). (Photo by C. J. Pierson.)

several small or one large black blotch in the middle of the elytra. It breeds in dead California Christmas berry and California laurel in California. *Schizax senex* Lec.

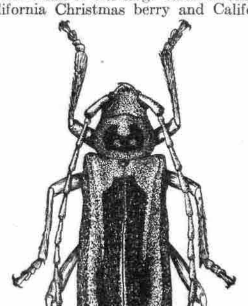

FIG. 363.—*Hoplopleura marginata* Leconte. (Drawing furnished by E. C. Van Dyke.)

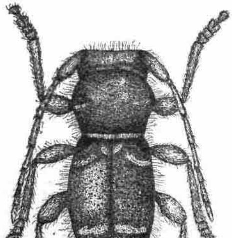

FIG. 364.—The hairy borer, *Ipochus fasciatus* Leconte. (Drawing furnished by E. C. Van Dyke.)

has been reared from dead portions of the apricot tree in New Mexico, and also occurs in Arizona. It is a serious pest to mesquite. *Ipochus fasciatus* Lec. (Fig. 364) is 5–8

mm. long, dark mahogany brown, the base and apical half of the abdomen covered with gray scales, and the whole body thinly clothed with long whitish hairs. The adults are often taken on or under the bark of dead standing trees. The larvæ mine the limbs and twigs of cottonwood, laurel, sumach, sour berry, apple, oak, and willow. The species is common in Southern California.

The spotted pine sawyer, *Monochamus maculosus* Hald. (*Monohammus*) (Fig. 365), is 14–27 mm. long, slender, coarsely punctured, the antennæ as long or two and one-half times as long as the body; dark brown, with bluish gray maculations on the dorsum. The head and prothorax are nearly equal in width, the latter with a prominent median tooth on each

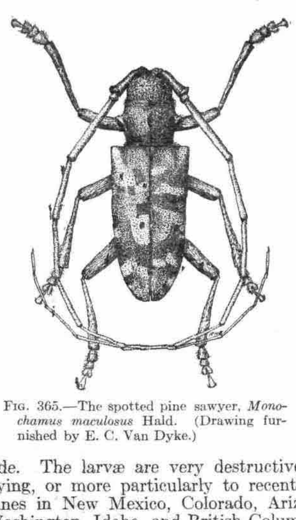

FIG. 365.—The spotted pine sawyer, *Monochamus maculosus* Hald. (Drawing furnished by E. C. Van Dyke.)

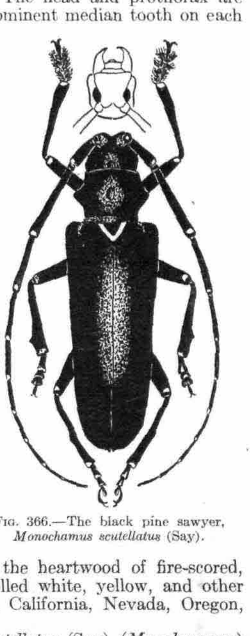

FIG. 366.—The black pine sawyer, *Monochamus scutellatus* (Say).

side. The larvæ are very destructive to the heartwood of fire-scored, dying, or more particularly to recently felled white, yellow, and other pines in New Mexico, Colorado, Arizona, California, Nevada, Oregon, Washington, Idaho, and British Columbia.

The black pine sawyer, *Monochamus scutellatus* (Say) (*Monohammus*) (Fig. 366), is 16–31 mm. in length, shining bronzy black with white scutellum, coarsely punctured, prothorax with large median tooth on each side, antennæ slightly longer or slightly more than twice as long as the body. The variety *oregonensis* Lec., is black with gray maculations. The large white grubs are very destructive and excavate extensive burrows through the sapwood and into the heartwood of fire scorched, declining,

injured, dead, and recently felled white pine, mountain or silver pine, Douglas fir, and other coniferous trees in the pine belts of North America. This species occurs in mountains of New Mexico, Colorado, California, Nevada, Oregon, Washington, Idaho, British Columbia, and probably other Western States.

The spotted tree borer, *Synaphæta guexi* (Lec.) (Fig. 367), is 15–23 mm. long, rather short, robust, flat across the dorsum, rough; the antennæ well curved and as long as or longer than the body, the joints tipped with bluish gray; prothorax slightly wider than the head and with a blunt lateral median tooth; the color bluish gray, minutely punctured and marked with black and orange. It is a very striking species common in California and ranging north into British Columbia. The adults fly at night. The larvæ breed in injured, dying and dead trees, burrowing into the heartwood of California buckeye, California laurel, cottonwood, maple, chestnut, fig, willow, poplar, walnut, cherry, wistaria, and many other forest, shade, and fruit trees and shrubs. Infestation of living trees usually starts at old wounds. Dead wood may be entirely consumed. *Graphisurus obliquus* (Lec.) (*Acanthocinus*) measures 10–12 mm., is gray with black zigzag lines on the elytra, and black markings on the antennæ, legs and dorsum. It has very long antennæ, a pair of lateral prothoracic teeth, and often a long visible ovipositor. The larvæ mine the sapwood of injured, dying and dead yellow pine in the mountains of New Mexico, Colorado, Nevada, and California. *G. spectabilis* (Lec.) is a much larger species being 19–23 mm. long, gray with black elytral bands and minute black punctures on the body and legs. The antennæ are several times longer than the body and there is a noticeable enlargement at the apex of the sixth joint. The prothorax has a pair of lateral teeth and a number of short blunt dorsal teeth or projections. It breeds in the sapwood of injured and dead trees, stumps, and logs of yellow and other pines in New Mexico, Arizona, California, Nevada, Oregon, Washington, and British Columbia.

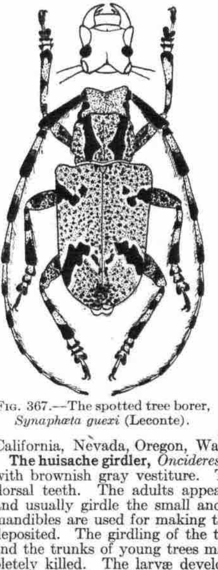

FIG. 367.—The spotted tree borer, *Synaphæta guexi* (Leconte).

The huisache girdler, *Oncideres trinodatus* Casey,[1] is 18–24 mm. long, black, clothed with brownish gray vestiture. The pronotum has a pair of lateral and three median dorsal teeth. The adults appear from early September until the last of November and usually girdle the small and quite large branches near the base, after which the mandibles are used for making the cavities under the bark in which the eggs are later deposited. The girdling of the twigs and limbs often seriously injures the large trees, and the trunks of young trees may be girdled near the ground and the tops thus completely killed. The larvæ develop in the dead portions above the girdle and require 8 or 9 months to mature. There is but a single brood. The species attacks huisache, huajilla, mesquite, and parkinsonia, and ranges from Mexico into Texas, New Mexico, and Arizona. Several natural enemies are recorded. Control consists in cutting out and burning the girdled portions from January to August. **The oak girdler,** *O. quercus* Skinner, is 11–13 mm. long, slender, clothed with gray pubescence, with reddish and brownish markings and spots. It girdles the limbs and young shoots of oak in Arizona. **The mesquite girdler,** *O. pustulatus* Leconte (Fig. 368), is 12–16 mm. long, brown with gray pubescence on pronotum, middle, and tips of elytra, and with rust colored spots on the dorsum. It girdles mesquite in Southern California, Arizona, New Mexico, and Texas.

[1] According to T. L. Casey, *Oncideres putator* Thomas is a tropical species confined to Southern Mexico and Central America. *Mem.* 4, 1913, p. 354.
M. M. High, Bul. 184, *Prof. Paper*, U. S. Dept. Agr. 1915.

The round-headed apple tree borer, *Saperda candida* Fabr., is the well known eastern apple pest. It is a striking beetle 12–20 mm. long, legs gray, body silvery white beneath and brown above with two wide white stripes extending the full length. The pale brownish oval eggs are 3 mm. long and inserted singly in the bark usually near the base of the trunks and, rarely, in the larger limbs. The larvæ are yellowish, 20–30 mm. long, and mature in 3 years. They mine the bark and sapwood of the trunks and larger limbs of healthy trees during the first year and the heartwood during the second and third years. Pupation occurs in a chamber, the adults emerging in the spring of the fourth year. Considerable injury is done to apple, quince, choke cherry, Juneberry, mountain ash, and hawthorn. The species extends west into New Mexico and has also been recorded in British Columbia.[1]

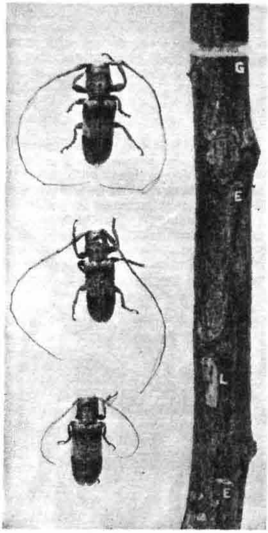

FIG. 368.—The mesquite girdler, *Oncideres pustulatus* Lec. Adult beetles and branch of mesquite showing: G, girdle; E, egg cavities; L, newly hatched larvæ beginning to burrow beneath the bark.

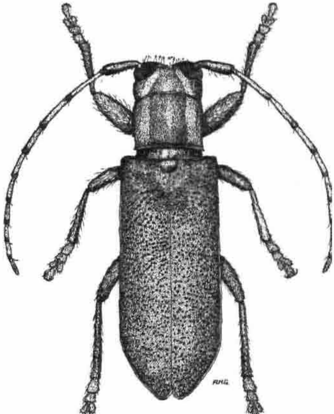

FIG. 369.—The European poplar borer, *Saperda populnea* (Linn.). (Drawing furnished by E. C. Van Dyke.)

The aspen borer, *Saperda calcarata* Say,[2] is 21–30 mm. in length, elongate, robust, reddish brown, densely clothed with gray and yellow pubescence, with the front of the head, three stripes on the pronotum, scutellum, and numerous markings on the

[1] J. W. Eastman, Bul. 68, Dept. Agr. Hort. Branch, B. C. 1916.

[2] Geo. Hofer, "The Aspen Borer and How to Control it." *Farmers' Bul.* 1154, U. S. Dept. Agr. 1920.

elytra orange yellow. The larvæ attack and greatly injure or completely kill cottonwoods, poplars, aspen, willows, and so forth. The species ranges throughout much of the country and is known in Colorado, Eastern Oregon, Nevada, and British Columbia in the west. To control this borer, cut down and burn brood trees in May and June. *S. concolor* Lec. is 6–20 mm. long, black, clothed with fine gray pubescence. It breeds in poplars and willows in Arizona, New Mexico, Colorado, and many parts of the east. *S. horni* Joutel is 16–20 mm. in length, shining black, clothed with dense light yellowish gray pubescence arranged in blotches and broken longitudinal lines on the dorsum. It breeds in willow in the higher mountains of California, Oregon, and Washington. *S. populnea* (Linn.) (Fig. 369) is 12 mm. long and gray with yellow markings. It infests poplars and is a European species which occurs in New Mexico, Arizona, California, Nevada, Washington, Wyoming, and other parts of the United States. The form *tulari* Felt and Joutel is the one taken in Arizona, California, and Washington.

The cottonwood twig borer, *Oberea quadricallosa* Lec., measures 11–14 mm., is cylindrical, very slender, the prothorax, legs, and abdomen orange, the remainder dull grayish black with four small black spots on the pronotum. It breeds in the living

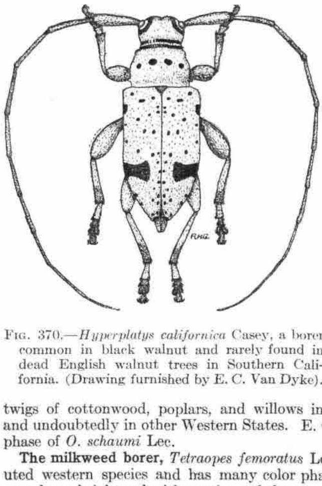

FIG. 370.—*Hyperplatys californica* Casey, a borer common in black walnut and rarely found in dead English walnut trees in Southern California. (Drawing furnished by E. C. Van Dyke).

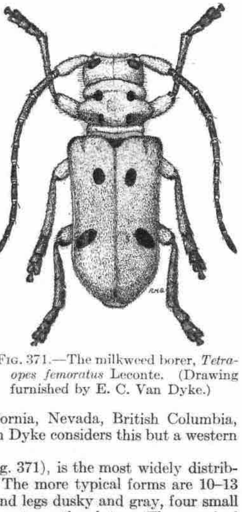

FIG. 371.—The milkweed borer, *Tetraopes femoratus* Leconte. (Drawing furnished by E. C. Van Dyke.)

twigs of cottonwood, poplars, and willows in California, Nevada, British Columbia, and undoubtedly in other Western States. E. C. Van Dyke considers this but a western phase of *O. schaumi* Lec.

The milkweed borer, *Tetraopes femoratus* Lec. (Fig. 371), is the most widely distributed western species and has many color phases. The more typical forms are 10–13 mm. long, bright red with portions of the antennæ and legs dusky and gray, four small black spots on the pronotum, and four larger black spots on the elytra. The marginal bases of the latter together with the scutellum are also dusky or black. The adults commonly frequent milkweeds where they occur during the summer and the larvæ live in the stems and roots. This species is known in British Columbia, Washington, Oregon, California, Nevada, Utah, Colorado, Arizona, and New Mexico, and extends into the middle States. *T. canescens* Lec. is smaller, averaging from 8–10 mm. in length and the dorsum is dull orange, clothed with fine gray pubescence, but otherwise similarly marked. It occurs in Texas, New Mexico, and Colorado.

CHRYSOMELIDÆ.[1] Leaf Beetles, Chrysomelid Beetles.

This is a very large and destructive family of mostly minute or small black, brown, iridescent blue, green, bronze, or purple, and brightly colored beetles. The adults and the larvæ of many species are largely leaf feeders, while the larvæ of many other species live in the ground and feed on the roots and tubers of plants. As a whole it is probably the most injurious family of the order. Control measures consist chiefly in the use of poison sprays and dusts, but contact insecticides are often valuable for the leaf-feeding larvæ.

Members of the genus *Donacia* are subaquatic in habits and feed on pond lilies, pickerel weed, and other plants growing in wet or damp places. *D. femoralis* Kirby is 8 mm. long, green-bronze, and minutely and thickly punctured. It occurs in Washington, British Columbia, Alaska, and throughout boreal North America. *D. emarginata* Kirby is 5–7 mm. in length, dark metallic blue above and pubescent beneath. It is abundant throughout much of North America and occurs in Colorado, California, Oregon, Washington, and British Columbia in the west. *D. pusilla* Say is 6–8 mm. long, iridescent brassy green or bronze with parts of the legs reddish. It is a boreal species in North America and is abundant in Colorado, Wyoming, Montana, Idaho, Nevada, California, Oregon, Washington, and British Columbia.

The western fruit beetle, *Syneta albida* Lec.,[2] is 8–11 mm. long, slender, variable in color from pale yellowish white to dull yellowish brown often with darker stripes. The adults appear in early spring and often do serious damage by eating the blossoms and young leaves of apple, cherry, peach, pear, prune, plum, quince, and other fruit trees, currant, gooseberry, and strawberry, as well as by feeding on the foliage of clover, hazelnut, filbert, vine maple, wild crabapple, and other plants in Northern California, Oregon, Washington, and British Columbia. *S. carinata* (Mann.) has the head and prothorax shining black, the elytra yellowish brown with black sutural margins, body brownish, and legs black. It occurs on the true firs in practically every Western State and extends northward into Alaska. *S. simplex* Lec. is entirely yellowish brown or with four well developed darker lines on the elytra, and the head and thorax sometimes darker. It ranges from Northern California into Alaska and normally feeds on oaks but also injures fruit trees.

The asparagus beetle, *Crioceris asparagi* (Linn.) (Fig. 372), is 5–7 mm. long, steel blue, the prothorax and lateral margins of the elytra reddish and with two or three pairs of yellowish spots on the sides of the elytra. The dull brown or dusky elongated eggs are 1 mm. long and glued singly on the small leaflets of the asparagus plants during the spring. The larvæ are dull olive green or brownish black, robust, and 7–10 mm. long when mature. They may attack the young shoots shortly after coming through the ground, but are chiefly a pest to the mature plants which are often

[1] Chas. W. Leng, "Rev. of the *Donaciæ* of Boreal Am." *Trans. Am. Ent. Soc.*, 18, p. 159, 1891.

Geo. H. Horn, "Syn. of *Halticini* of Boreal Am." *Trans. Am. Ent. Soc.*, 16, p. 163, 1889. "Studies in *Chrysomelidæ*." *Trans., Am. Ent. Soc.* 19, p. 1, 1892. "The *Eumolpini* of Boreal Am." *Trans. Ent. Am. Soc.*, 19, p. 195, 1892. "The *Galerucini* of Boreal Am." *Trans. Am. Ent. Soc.*, 20, p. 57, 1893.

[2] H. F. Wilson and G. F. Mozenette, *Second Bien. Crop Pest and Hort. Rept.* 1913–14, Ore. Agr. Exp. Sta. 1915, p. 96.

G. F. Mozenette, *Jour. Econ. Ent.*, 9, p. 458, 1916.

completely defoliated. When mature the larvæ go into the soil and pupate in a thinly lined pupal cell. The entire life cycle requires about a month and there are three or more broods a year. The adults hibernate

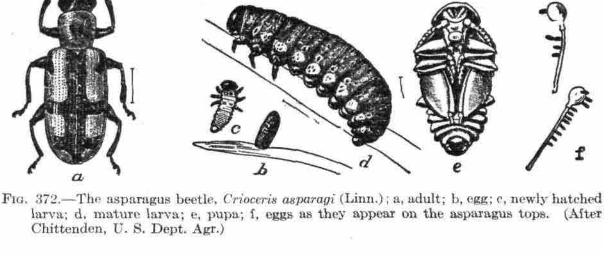

FIG. 372.—The asparagus beetle, *Crioceris asparagi* (Linn.); a, adult; b, egg; c, newly hatched larva; d, mature larva; e, pupa; f, eggs as they appear on the asparagus tops. (After Chittenden, U. S. Dept. Agr.)

in rubbish about the fields. The species is European and has been distributed in many parts of North America. In the west, it is abundant in the delta asparagus-growing districts of California and also occurs in Colorado and Oregon. The larvæ of ladybird beetles and predaceous plant bugs extensively prey on the larvæ. Control measures consist in dusting the seed plants with powdered arsenate of lead. The writer has had good success in killing the young larvæ with 5 per cent nicodust.

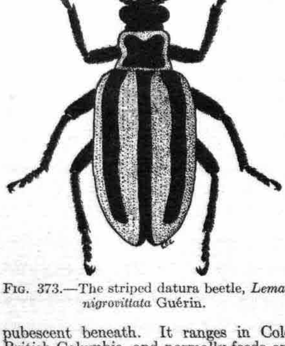

FIG. 373.—The striped datura beetle, *Lema nigrovittata* Guérin.

The striped datura beetle, *Lema nigrovittata* Guérin (Fig. 373), is 7–8 mm. in length, black, portions of the prothorax and the elytra brown, the latter with two black longitudinal stripes. The eggs are pale orange and are laid in clusters of 4 to 20 on the leaves. The larvæ are blackish and often covered with dirt. All stages are found on Jimpson weed which is apparently the native host, and also on burgmansia and cestrum. It is a Mexican species ranging into New Mexico, Arizona, and California, and is often mistaken for the western striped cucumber beetle, *Diabrotica trivittata* (Mann.), which is much smaller. *Lema concolor* Lec. feeds on ferns at the very high altitudes of New Mexico.

The red-shouldered leaf beetle, *Saxinis saucia* Lec., is 4–5 mm. long, robust, metallic blue above with a conspicuous red spot at the marginal base of each elytron and grayish pubescent beneath. It ranges in Colorado, California, Oregon, Washington, and British Columbia, and normally feeds on wild buckwheat, California Christmas berry, and ceanothus, but often injures fruit trees, having been observed eating the young

buds of prunes and causing holes in the leaves of almond, apricot, plum, prune, and nursery stock. The larvæ live in the nests of several species of ants. The eggs are covered with brownish wax and have about eight longitudinal bands or ribs and resemble "brown seeds or shriveled flower buds." They are probably collected by ants, since the case-bearing larvæ are known to inhabit ants' nests. (E. C. Van Dyke, *Pan-Pacific Ent.* 1, p. 175, 1925. F. J. Spruÿt, *Pan-Pacific Ent.* 1, p. 176–8, 1925).

Members of the genus *Pachybrachys*[1] are small, robust, cylindrical species, feeding mostly on native plants. *P. bivittatus* (Say) is 3.9 to 5 mm. long, yellow, pronotum suffused with reddish, and each elytron with a median black or brown vitta and one to three lateral spots. It feeds on willow throughout North America and occurs in New Mexico, Colorado, Montana, Utah, California, and Oregon in the west. *P. donneri* Crotch is 3–4.5 mm. long, black with grayish pubescence, the thorax with yellow sides and the elytra with base and one-third of the external margin yellow. It is common on willows in the Sierras of California and Nevada and ranges into Washington. *P. livens* Lec., measures 2.7 mm., is pale yellow, the prothorax with a reddish brown or pale median stripe. It occurs on willow in California and probably occurs in the adjoining States of Arizona and New Mexico. *P. melanostictus* Suffrian is 3 mm. long, mottled black and dull yellow. It feeds on willow in Colorado, Arizona, Utah, Idaho, Nevada, California, Oregon, Washington, and British Columbia. *P. bullatus* Fall is 2.7 mm. in length, polished yellow mottled with pale or dark brown. It feeds on wild gooseberry in Arizona and is also reported in Texas. *P. calidus* Fall is 3.1 mm. long, dull yellow with broad dusky markings, and occurs on cat's claw in Arizona, New Mexico, and Texas. *P. hybridus* Suffrian is 3.75 mm. long, shining black, the prothorax varying from black to red. It infests wild rose in California, Lower California, New Mexico, and Texas. *P. lustrans* Lec. is 4 mm. long and black marked with bright yellow. It feeds on ceanothus in California and Lower California. *P. nobilis* Fall is 5.8 mm. long, yellow with reddish punctures on the pronotum and black elytral spots. It occurs on yellow pine in Arizona. *P. fuscipes* Fall is 4.5 mm. long, dull yellow, the pronotum and elytra suffused with reddish brown. It occurs in New Mexico. The variety *purgatus* Fall is brighter and more reddish, and infests yellow pine in Arizona. *P. prosopis* Fall is but 2.6 mm. in length, dull or reddish brown with darker maculations. It infests mesquite in the desert areas of Southern California and Arizona. *P. varicolor* Suffrian is 4.25 mm. long, polished yellow, thickly mottled with brown or black. It occurs on white fir in Colorado, New Mexico, and Arizona.

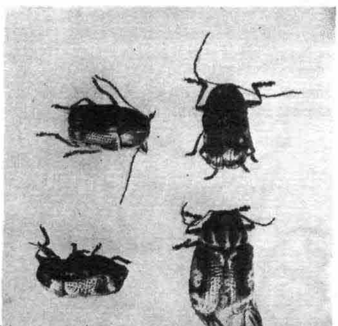

FIG. 374.—The castaneous beetle, *Cryptocephalus castaneus* Leconte.

The castaneous beetle, *Cryptocephalus castaneus* Lec. (Fig. 374), is 3–5 mm. in length, robust, black with red, orange, or yellow markings on the head, pronotum, and elytra. The normal food plant is willow, but it also feeds on the leaves of wild and cultivated blackberries and roses, strawberries, wild licorice, and prune. It occurs throughout California. *C. sanguinicollis* Suffrian is similar in size and shape, but shining black with bright reddish prothorax often suffused with black. It normally feeds on artemisia

[1] H. C. Fall, "A Rev. of N. A. Species of *Pachybrachys*." *Trans. Am. Ent. Soc.*, 41, p. 291, 1915.

but has been observed feeding on prune leaves by the writer. It occurs in California and Oregon.

The bronze willow flea beetle, *Diachus auratus* (Fabr.), is 1.5–2 mm. long, cylindrical and metallic bronze throughout. It occurs in many parts of South and North America and is very common on willow in New Mexico, Arizona, and California. It has also been observed by the writer as injurious to the tender shoots of prune trees in California.

The plum leaf beetle, *Nodonota tristis* (Olivier), is 3–4 mm. long, oval, convex, metallic blue with the legs and antennæ yellow. The species occurs commonly throughout many parts of North America and ranges west into Colorado and Arizona. The adults feed on the leaves of peach, plum, and other trees and shrubs. **The grape leaf beetle,** *Colaspis brunnea* (Fabr.) (*C. flavida* Say), is 4–6 mm. in length and variable from yellow to pale brown in color. It commonly feeds on grapevines and also to some extent on cotton in Arizona and New Mexico.

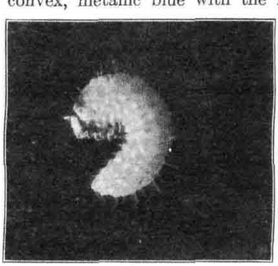

Fig. 375.—Larva of the grape root worm, *Adoxus obscurus* (Linn.). (After Quayle.)

The grape root worm, *Adoxus obscurus* (Linn.) (*A. vitis* Fourc., *Bromius*)[1] (Figs. 375, 376, 377), is 4 mm. long, robust, the prothorax narrower than the elytra, and entirely black or black with brown elytra. The adults appear in the spring and eat very characteristic linear holes in the grape

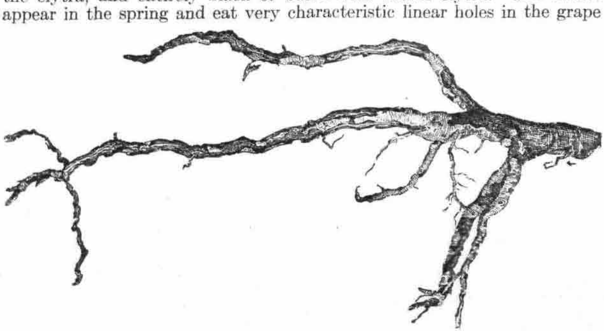

Fig. 376.—Work of the larvæ of the grape root worm, *Adoxus obscurus* (Linn.), on the roots of grape. (After Quayle.)

leaves. The small yellowish white elongated eggs are laid in clusters of from several to 25 in the cracks beneath the loose bark on the trunks of the vines, usually near the ground. They hatch in from 8 to 10 days and

[1] H. J. Quayle, *The California Grape Root-Worm*, Bul. 195, Cal. Agr. Exp. Sta. 1908.

the young larvæ make their way to the roots near the trunks where they often entirely destroy the smaller roots and cut linear grooves in the larger ones, which are often completely girdled and the vines killed. They become full grown and measure 7 mm. by fall when they construct a cell in the soil for hibernation and pupation the following spring. There is but a single brood. The roots and leaves of wild and cultivated grapes of all varieties and the fireweed are attacked, as are also the leaves of *Saxifraga peltata* Torr., in California. The beetle occurs in Europe, Siberia, and much of North America. Its western range is New Mexico, Colorado, Arizona, Utah, Nevada, California, Washington, British Colum-

FIG. 377.—*Work of the adults of the grape root worm, Adoxus obscurus (Linn.), on the leaves* and immature fruit of the grape. (After Quayle.)

bia, and Alaska. Control measures consist in spraying the vines in the spring with 3 pounds of powdered arsenate of lead to 100 gallons of water to kill the adults. The addition of 1 gallon of blackstrap molasses makes this spray more effective. Dusting with arsenate of lead and sulfur in equal proportions controls both the beetle and grape mildew. Paradichlorobenzene should prove satisfactory in killing the larvæ.

The southern corn-leaf beetle, *Myochrous denticollis* (Say), is 5 mm. long, bronze with brown and gray scales, the prothorax with three teeth on each lateral margin, and the lateral margins of the elytra minutely dentate. The adults attack young corn plants as they appear above the ground in the spring and later on eat holes in the blades of large plants. They also feed on wild grasses and timothy, and range from the Southern States into New Mexico and Arizona. **The long leaf beetle,** *Myochrous longulus* Lec., is similar in size and color. It is an arid species commonly feeding on arrow weed, baccharis, trailing malva, cocklebur, and weeds, but is often very injurious in the spring to cotton seedlings, young cantaloupe plants,

and the buds of grape in Arizona, Colorado, and Southern California. *M. squamosus* Lec. is another similar species reported as destroying the buds of pear grafts in Colorado. It also occurs in Wyoming, Montana, New Mexico, and Arizona.

The gray leaf beetle, *Glyptoscelis albida* Lec. (*G. longior* Lec.), is 6–7 mm. long, robust, metallic bronze clothed with fine gray scales. The adults appear in the spring and devour the buds and leaves of apple, pear, and other fruit trees, although the normal food plants are incense cedar and other coniferous trees. The species occurs in California, Nevada, Oregon, Washington, Idaho, and British Columbia. *G. squamulata* Crotch has been taken on grapes in Southern California and ranges into Arizona, Nevada, Utah, and Oregon. *Colaspidea smaragdula* (Lec.) is 4–5 mm. long, varying from bright green to steel blue, with a few short white hairs. It normally feeds on artemisia but not infrequently invades the foothill orchards and feeds on the foliage of apple, grape, and other trees, in California.

The strawberry rootworm, *Paria canella* (Fabr.) (*Typophorus canellus* Fabr.),[1] is 2.5–3 mm. in length, shining pale or dark brown, usually with four large irregular black blotches on the elytra which may coalesce to cover nearly the entire dorsum. There are many varieties based on different colorations. The adults hibernate in the refuse and soil, appear in

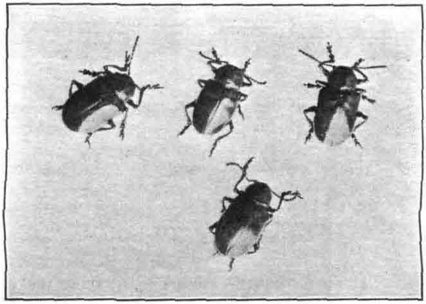

FIG. 378.—The blue milkweed beetle, *Chrysochus cobaltinus* Leconte.

the spring, and eat innumerable small round or irregular holes in the leaves of the plants. The small elongated pale yellow eggs are laid on the sides in clusters of 2–10 on old or dead leaves near the ground, and hatch in from 7–15 days. The larvæ are 5 mm. long when mature, white with brown heads, and are slightly curved. They live in the soil and feed on the roots of the plants. Pupation also occurs in the soil. There are two broods annually. The greatest injury in the west is to cultivated strawberries, large areas of which are completely killed by the larvæ. The work, however, is usually spotted, and dead areas of variable sizes may

[1] C. A. Weigel and E. L. Chambers, *Jour. Econ. Ent.*, 13, p. 226, 1920.
C. A. Weigel and C. F. Doucette, *Farmers' Bul.* 1344, U. S. Dept. Agr. 1923.
C. A. Weigel, *Dept. Bul.* 1357, U. S. Dept. Agr. 1926. (Complete Bibliography). Our western form is appareantly the var. *quadrinotata* (Say).

appear in the fields. Besides strawberries, greenhouse roses are very greatly injured in the States east of the Rocky Mountains. Raspberries and blackberries are also injured by the larvæ. In addition to the above food, the adults feed on the leaves of apple, mountain ash, walnut, potatoes, and many other plants. It is a species indigenous to much of North America and occurs in New Mexico, Arizona, and California in the west. The application of strong arsenate of lead or calcium arsenate, 4 pounds to 50 gallons of water, to kill the adults, the rotation of crops, and the destruction of infested areas and patches offer about the only control methods under field conditions.

The blue milkweed beetle, *Chrysochus cobaltinus* Lec. (Fig. 378), is a beautiful metallic green to dark blue species, 9–10 mm. long, which is very common on milkweed throughout parts of New Mexico, Arizona, California, Oregon, Washington, and British Columbia. The adults occasionally feed on peach and oleander.

The red turnip beetle, *Entomoscelis adonidis* (Pallas), is 7 mm. long, bright red with black patches on the head and pronotum, and three black lines on the elytra. The eggs are bright red and elliptical. They form the overwintering stage and hatch in the spring. The larvæ are first orange with black spots, becoming black when mature, and attain a length of 12 mm. They are nocturnal and feed during the night. Pupation occurs in the soil, the pupæ being bright orange. The larvæ and adults feed on cabbage, radishes, turnips, wallflower, and other cruciferous plants in boreal North America, Siberia, and Europe. In the west this species occurs in the mountains of Colorado, Montana, Washington, British Columbia, and Alaska.

The Colorado potato beetle, *Leptinotarsa decimlineata* (Say) [1] (*Doryphora*) (Fig. 379), is one of the most famous and best known of injurious American insects. It originated in the Rocky Mountain region and from 1850 to 1874 travelled eastward to the Atlantic and afterwards spread to all parts of the continent excepting Nevada and California where it has not yet become established. The spread to parts of Oregon and Washington have been comparatively recent. It also occurs in the Fraser Valley of British Columbia. Wherever it occurs in the west it is uncertain in its attacks and may or may not be a serious pest. The adults are 6–12 mm. long, oval, convex, polished dark brown, the dorsum yellowish with black mottlings on the head and pronotum, and ten black longitudinal stripes on the elytra. They hibernate and emerge in early spring to lay the oval, orange eggs in clusters of ten or more on the lower surfaces of the leaves of potatoes and other food plants. They hatch in about a week into small dark larvæ which rapidly grow into veriegated orange or red, soft, humped grubs which have two rows of dark spots along each side. They are ravenous eaters and mature in two or three weeks, drop to the ground, and pupate in the soil. The adults emerge in 10–15 days. There are two broods, the fall adults appearing in September and hibernating, and the summer adults, in July, although the broods are very uneven and overlapping. The native food plants consist of *Solanum rostratum* Dunal, and probably other nightshades, from which the beetle moves over to the potato, to-

[1] P. M. Johnson and A. M. Ballinger, "Life-History Studies of the Colorado Potato Beetle." *Jour. Agr. Research*, 5, p. 917, 1916.

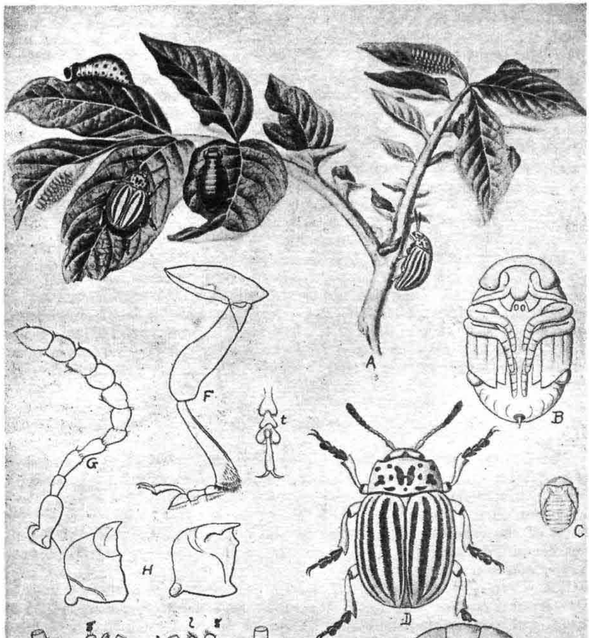

FIG. 379.—The Colorado potato beetle, *Leptinotarsa decimlineata* (Say). A, potato plant showing eggs, larvæ and adult beetles in natural attitudes. B, and C, pupæ removed from the soil; D, adult; E, mature larva; F, leg of adult; t, tarsus of same; G, antenna of adult; H, mandibles of adult; I, mouth parts of adult with mandibles removed; c, cardo; g, galea; l, lacinia; la, labium; lap, labial palpus; mx, maxilla; mxp, maxillary palpus; s, stipes; sg, subgalea. (After Theodor Fischer.)

mato, tobacco, peppers, and other solanums. The tachina fly, *Phorocera doryphoræ* (Riley) commonly attacks the adult beetles and the predaceous bugs, *Stiretrus anchorago* (Fabr.), *Perillus bioculatus* (Fabr.), and *Podisus maculiventris* (Say), prey on the larvæ. Control measures consist in spraying with Bordeaux mixture and arsenate of lead, or dusting with arsenate of lead as soon as the beetles appear in the spring.

The green dock beetle, *Gastroidea cyanea* Melsh., is 4–5 mm. in length, bright metallic green above in living, and, rarely, blue in museum specimens; the body, antennæ, and legs black or iridescent. The adults appear in early spring, usually in March, and

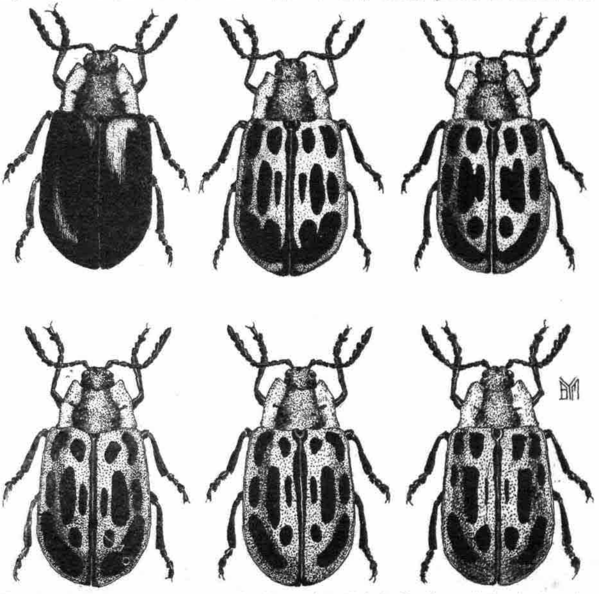

FIG. 380.—The cottonwood leaf beetle, *Lina scripta* (Fabr.), showing variation in the color patterns of the adults.

lay large masses of bright orange, elongated eggs on the leaves of the dock plants. The black larvæ eat away all but the larger veins and nearly defoliate the plants. Pupation occurs in the ground. There are two broods. Rhubarb is also attacked and adults have been observed feeding on almond trees. The species is very common in California and Oregon. *G. dissimilis* (Say) is common on dock in Colorado. *G. viridula* (De Geer) (*G. formosa* Say) occurs on dock in New Mexico, Montana, and Arizona, and has been reported as a pest to grapes in the latter State. It is a European and Siberian species occurring in various parts of North America.

The cottonwood leaf beetle, *Lina scripta* (Fabr.), (Fig. 380), is 7–9.5 mm. long, metallic dark purple or blackish with broad lateral orange margins on the prothorax, and the elytra yellowish with usually 7 purplish spots on each elytron, although there are many variations in the pattern as shown in the accompanying illustration (Fig. 380). The larvæ completely destroy all of the leaves excepting the fine network of veins, and feed on cottonwood, poplars, and willow, and not infrequently defoliate completely large areas. The beetle occurs throughout the country and is common in New Mexico, Colorado, Wyoming, Montana, Nevada, California, and probably occurs in all of the Western States. **The willow leaf beetle,** *Lina interrupta* (Fabr.) is smaller than the above, averaging 7 mm. in length, and has a spotted form similar to the cottonwood leaf beetle, though it also has a common color form with immaculate dark metallic purple elytra. The two color phases occur in both sexes. The larvæ are rough, black, and attain a length of 8–10 mm. when mature. They feed on willow and leave only the veins of the leaves. When mature they hang by the tail and pupate head downwards, often crowded on the leaves and twigs. It is a boreal species occurring in Europe, Siberia, China, and North America. In the west it ranges from California into Alaska. **The California willow beetle,** *Lina californica* Rogers, is 4–5 mm. long, black, the dorsum shining bluish green and rather coarsely punctured. It also feeds on willow, often completely stripping the trees in California. **The unspotted aspen leaf beetle,** *Lina tremulæ* (Fabr.), a bronze black beetle with red elytra and somewhat larger than any of the other species, is now becoming quite abundant and injurious to poplars in Northern California and the Pacific Northwest. It is of European origin and well known in the east. (Van Dyke.)

FIG. 381.—Work of the elm leaf beetle, *Galerucella xanthomelæna* (Schrank), on the leaves of elm. The small round holes near the bottom were made by the adults; the rest of the work is that of the larvæ.

The goldenrod beetle, *Trirhabda*[1] *canadensis* (Kirby), measures 7–9.5 mm., is yellowish above with a broad black stripe on the side of each elytron, a dark spot on the head, and three on the pronotum. The larvæ and adults feed on the goldenrod and are recorded by A. W. Morrill as defoliating sage in Arizona. It is the most widely distributed member of the genus, occurring throughout much of the continent and ranging west into Colorado, New Mexico, Arizona, Utah, and California. *T. flavolimbata* (Mann.) is yellowish with dusky markings on the head and pronotum and iridescent green or blue elytra which are margined laterally with yellow. The larvæ are blackish brown. This beetle is a general feeder on artemisia, senecio, goldenrod, and pickle weed, ranging from the middlewest into New Mexico, Arizona, Colorado, Utah, California, and Nevada. *T. luteocincta* (Lec.) is 5–9.5 mm. long, the elytra varying from iridescent green to blue and dark purple. The larvæ are metallic dark bluish green and feed on artemisia in Mexico, New Mexico, Arizona, and Southern California.

The sunflower beetle, *Galerucella notata* (Fabr.) (*Galeruca*), is 3.5–5 mm. in length opaque dull yellow, sparsely pubescent, each elytron with a sutural and three discal vittæ, the inner one short and basal. It feeds on the leaves of wild and cultivated sunflowers and ranges west into Colorado and New Mexico. *Zygogramma exclamionis* (Fabr.), also feeds on the wild and cultivated sunflowers in New Mexico, Colorado, Wyoming, and Montana. **The cherry leaf beetle,** *Galerucella cavicollis* (Lec.), is 4.5–5.5 mm. long, bright red, with the antennæ, eyes, and apices of the legs black. The eggs are pale yellow and the larvæ reddish brown with black markings. The species occurs

[1] Geo. H. Horn, "Species of *Trirhabda*." *Trans. Am. Ent. Soc.*, 20, p. 63, 1893.

throughout the east and feeds on the foliage of cherry and peach. It is reported in the west in British Columbia. **The western willow leaf beetle,** *Galerucella decora* (Say), is 4.5–5.5 mm. long and dull yellow, brown, or black, with short pubescence. It is common throughout the country on willows and poplars. The eastern form is pale, while the western form is dark and is recorded from New Mexico, Colorado, Oregon, and Washington. **The elm leaf beetle,** *Galerucella xanthomelæna* (Schrank) (*G. luteola* Müller of American authors), is 5 mm. long, yellow or orange, with a median and lateral stripe and an elongated spot on each elytron black. The eggs are orange, attached at the larger end in irregular rows in clusters on the undersides of the leaves in June and again in July and August, there being two or three broods. The larvæ are dark with yellow stripes and prominent body tubercles, and attain a length of 12 mm. They feed extensively on the leaves of elms which are often seriously injured by the attacks (Fig. 381). The species was introduced into the United States from Europe about 1834 and now occurs in many of the eastern and middle States. It has in late years been found in Washington and Oregon, and was discovered in large numbers at Fresno, California, in 1924 by F. P. Roullard. By the middle of August of that year the larvæ and the adults of the third generation were appearing on the elm trees on 80 city blocks. Some of the trees had been defoliated three times and there were indications of a fourth brood. It is controlled by dusting or spraying with arsenate of lead.

The western beet leaf beetle, *Monoxia consputa* (Lec.), is 3.5–4.5 mm. long, pale yellowish brown throughout, sometimes with darker markings on the dorsum. The larvæ mine the leaves of atriplex and grindelia and the adults often seriously injure the tops of sugar beets. The species occurs in practically every Western State. *M. puncticollis* (Say) is a larger species, 7–8.5 mm. in length, of a uniform pale yellow or dark brown, the elytra often with the suture and lateral margins bordered with black. The eggs are dull brownish gray and the larvæ dark olive green or brown with pale yellow tubercles, and are 8 mm. long when full grown. The larvæ and adults feed on dondia, Russian thistle, atriplex, and sugar beets, often doing serious damage to the latter. This beetle ranges west through Mexico and Texas into New Mexico, Colorado, Montana, Idaho, Arizona, Utah, California, and Nevada. *M. debilis* Lec. is similar to *M. consputa* (Lec.), but is generally darker and a little smaller. It often seriously defoliates cottonwood and poplars in New Mexico, Arizona, Utah, Wyoming, Nevada, California, and Oregon.

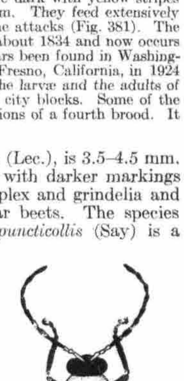

FIG. 382.—The twelve-spotted cucumber beetle, *Diabrotica duodecimpunctata* (Fabr.).

The twelve-spotted cucumber beetle, *Diabrotica*[1] *duodecimpunctata* (Fabr.) (Fig. 382), is 6 mm. long, bright green, with 12 black spots on the elytra, and with all the venter, excepting the metathorax, and the bases of the legs pale yellow. The yellow eggs are laid about the bases of the plants just beneath the surface of the soil and hatch in 7–10 days. The slender larvæ are yellowish white with black heads and thoracic shields. They feed upon the roots and tubers of various plants and often do considerable damage, especially to grasses, corn, millet, oats, rye, wheat, and weeds.

[1] Geo. H. Horn, Key to Species. *Trans. Am. Ent. Soc.*, 20, p. 89, 1893. F. H. Chittenden, Bul. 82, pt. 5, Bur. Ent. U. S. Dept. Agr., p. 67, 1910.

Pupation occurs in the soil. The adults are often serious pests, feeding on many kinds of plants including fruit trees, flowers, field, forage and

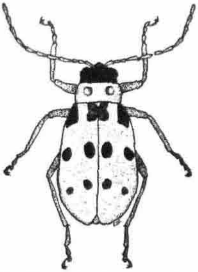

FIG. 383.—The obscure twelve-spotted cucumber beetle, *Diabrotica duodecimpunctata* (Fabr.) form *telella* Leconte.

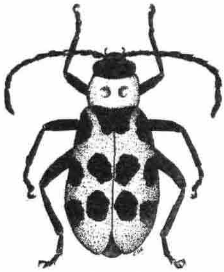

FIG. 384.—The western twelve-spotted cucumber beetle, *Diabrotica soror* Leconte.

truck crops, and particularly cucumbers, melons, squashes, and gourds. This species is largely eastern in distribution and extends west into New Mexico, Arizona, and the Imperial Valley, California, in the form *tenella* Lec. (Fig. 383), which has the elytral spots greatly reduced in size and number. **The western twelve-spotted cucumber beetle,** *Diabrotica soror* Lec. (Figs. 384, 385), replaces the above species in the region west of the Rocky Mountains. It differs in being somewhat smaller and in having the antennæ, legs, and body entirely black. The habits of the larvæ and adults are similar. During certain years the adults often appear in countless numbers soon after the native grasses and weeds dry up in the pastures and foothills, and swarm into the cultivated areas devastating flowers, lawns, ornamental trees and shrubs, truck, field and forage crops, fruit trees, and practically every green plant excepting conifers. The larvæ have been most often taken from the roots of corn, alfalfa, and sweet-peas, but probably feed naturally on the roots of grasses and weeds. The species occurs in

FIG. 385.—Larva of the western twelve-spotted cucumber beetle, *Diabroticia soror* Lec., and work on the roots of young corn plants.

Colorado, Arizona, California, and Oregon, being more abundant and injurious in the last two States. **The three-banded diabrotica,** *Diabrotica tricincta* (Say), is 5.5–6.5 mm. long, yellow, the head, metasternum, tibiæ, and tarsi black; the elytra has three transverse bands and a small apical spot of the same color. It occurs in Mexico, New Mexico, Colorado, and Arizona, and often seriously injures cantaloupes, watermelons, and other cucurbs. **The Colorado corn root worm,** *Diabrotica virgifera* Lec.,[1] is 5–6 mm. long, yellowish green, with a dark stripe on each elytron extending nearly to the apex or with the elytra wholly black, excepting the yellow margins and apices. The larvæ feed on the roots of corn plants which are often stunted and seriously injured. The species occurs in the plains areas of Colorado east of the Rocky Mountains. Rotation of crops is recomended as a con'rol measure. **The western striped cucumber beetle,** *Diabrotica trivittata* (Mann.) (Fig. 386), is 4–6 mm. long, black, the pronotum orange yellow, the elytra pale yellow with three black longitudinal

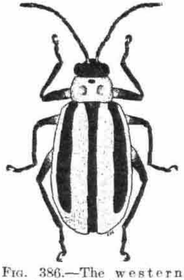

FIG. 386.—The western striped cucumber beetle, *Diabrotica trivittata* (Mann.).

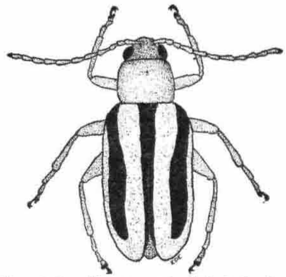

FIG. 387. — The two-striped leaf beetle, *Luperodes bivittatus* Leconte.

stripes, the basal half of the first antennal joint and the bases of the femora pale yellow. The larvæ commonly attack the roots of cucumbers, melons, pumpkins, squash, and other cucurbs, eating linear holes towards the bases of the plants, while the adults feed on the tops and also on beans, beets, corn, peas, sunflower, almond, apple, prune, and other plants. The species is most abundant and injurious in Southern California, but ranges into Arizona and Oregon. **The striped cucumber beetle,** *Diabrotica vittata* (Fabr.), of the Eastern States differs in having the antennæ entirely black. It ranges west into Colorado and New Mexico and has similar habits.

The two-striped leaf beetle, *Luperodes*[2] *bivittatus* Lec. (Fig. 387), is 4–5 mm. long, with orange head and pronotum, yellow elytra with two black stripes and black suture, legs yellow, and body shining black. The adults often appear in large numbers in May through July and eat curious fringes

[1] C. P. Gillette, *Jour. Econ. Ent.*, 5, p. 364, 1912.

[2] Geo. H. Horn, Key to Species. *Trans. Am. Ent. Soc.*, 20, p. 107, 1893.

around the edges and holes in the middle of leaves of almond, apricot, California buckeye, prune, and other fruit and native trees. The beetle occurs commonly in California.

The three-spotted bean beetle, *Cerotoma trifurcata* (Forster), is 3.5–5 mm. in length, yellowish buff to dull red, with three large black spots near the inner margin and a dark border on the outer margin of each elytron. In some cases the spots are merged to form a wide black margin around each elytron. The adults feed on bush clover, hog peanut, tick trefoil, beans, cowpeas, and other legumes. The species occurs in many parts of North America, and in New Mexico in the west.

The five-striped willow beetle, *Disonycha quinquevittata* (Say) (Fig. 388), is 5–9 mm. long, yellow or reddish beneath, yellow above, the pronotum usually with four black spots, and the elytra with five dark stripes. The adults and larvæ are often very abundant on and injurious to willow throughout the west. *D. pennsylvanica* (Illiger) is 6.5–7.5 mm. long, black, the margins of the pronotum and elytra white with four white vittæ on the latter. It feeds on arrow head, dock, knotweed, willow, and occurs in many parts of the country. The form *limbicollis* Lec. as described above is common in California and is occasionally taken on fruit trees.

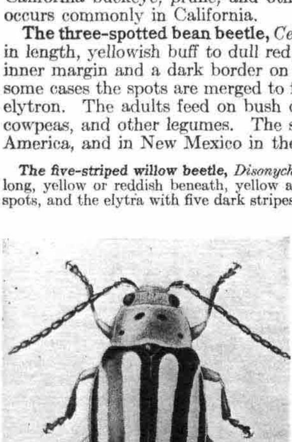

FIG. 388.—The five-striped willow beetle, *Disonycha quinquevittata* (Say). (Drawing by G. F. Mozenette.)

The members of the large genus *Haltica* (*Altica*)[1] are among the larger flea beetles, many of which are serious pests to deciduous forest, shade, ornamental, and fruit trees, vines, berries, and so forth. The larvæ, like the adults, are foliage feeders and perforate or skeletonize the leaves. **The alder flea beetle,** *Haltica bimarginata* Say[2] (Fig. 389), is 5–6 mm. long, metallic dark steel blue throughout and distinguished by the longitudinal fold on the sides of the elytra. The adults hibernate and appear in the early spring, depositing the yellow or pale orange, ovate-oblong, minutely punctured eggs 1.25 mm. long, in clusters, usually on the rolled leaves. These hatch in a few days into larvæ, the mature forms of which are 7 mm. long, dull brown or almost black with shining black head, prothoracic and anal shields and legs, and dull yellow venter. They skeletonize the leaves and often almost completely denude large trees over considerable areas. Pupation occurs in the ground and requires 6–10 days. There is but a single generation annually. It is a very common species throughout North America and is abundant in New Mexico, Colorado, Wyoming, Montana, Utah, Arizona, California, Nevada, Oregon, Washington, Idaho, British Columbia, and Alaska. The alder is the preferred food plant, but it also attacks poplars and willows and rarely feeds on other trees and shrubs.

The steel-blue grapevine flea beetle, *Haltica torquata* Leconte, measures 3–4 mm., is metallic blue or purple, and often appears in countless numbers in the vineyards of New Mexico, Arizona, and Southern California. The native hosts are the desert and other evening primroses. The writer has

[1] W. C. Woods, *Biology of Maine Species of Altica*. Bul. 273, Maine Agr. Exp. Sta. 1918.

[2] W. C. Woods, *Biology of the Alder Flea-Beetle*. Bul. 265, Maine Agr. Exp. Sta, 1917.

taken it at Lake Tahoe in California and in Nevada on a small evening primrose. This species has in the past been generally confused with *H. carinata* Germ., which does not occur in the west.

The apple flea beetle, *Haltica foliacea* Lec. (*H. punctipennis* Lec.), is 3–4.5 mm. long and metallic bright green or dark blue. It normally feeds on evening primrose, but strips grapevines and apple, and also feeds on raspberries, strawberries, radish, greasewood, weeds, and so forth, in California, Arizona, New Mexico, Colorado, Texas, and Mexico.

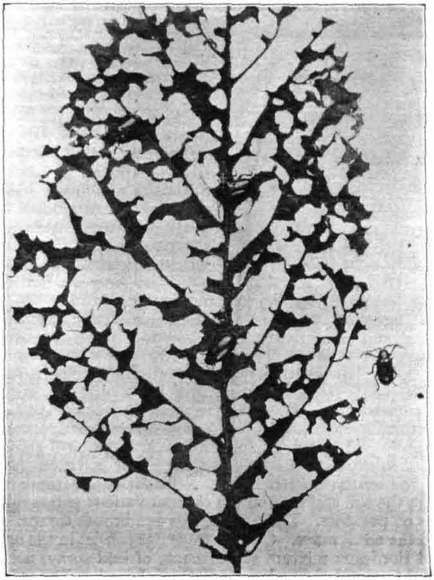

FIG. 389.—The alder flea beetle, *Haltica bimarginata* Say, and work on alder leaf.

The strawberry flea beetle, *Haltica ignita* Illiger (Fig. 390), is 3–4 mm. in length, metallic green, golden bronze, or purple. It feeds on many plants including strawberry, kalmia, evening primrose, fuchsia, and fireweed, and is known in various parts of the east. It is reported from Colorado, Arizona, California, and Washington in the west. *H. evicta* Lec. is 4.5 mm. long, metallic brass or bronze in color, and reported as injurious to strawberries and roses in California and Oregon. It is also known in British Columbia and Colorado.

The rose flea beetle, *Haltica probata* Fall,[1] is 3.7–4 mm. long and metallic green or bronze. The larvæ and adults feed on wild and cultivated roses and strawberries in California, Oregon, Washington, and British Columbia. The two preceding species, *H. ignita* Ill. and *H. evicta* Lec., may prove to be this species.

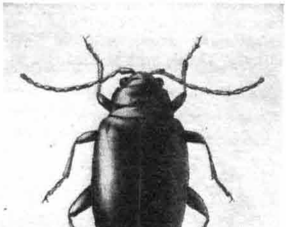

FIG. 390.—*Haltica ignita* Illiger. (Drawing by G. F. Mozenette.)

The mustard flea beetle, *Hemiglyptus basalis* (Crotch), is 3–3.5 mm. long, elongate, and metallic greenish bronze with reddish brown antennæ and legs. It is common on cabbage, mustard, radish, rape, turnips, and other wild and cultivated cruciferous plants in California, but the native host is yerba santa or mountain balm. **The willow flea beetle,** *Chalcoides helxines* (Linn.), is 2.5–3.3 mm. in length, oblong-oval, metallic green-blue or bronze with the antennæ and legs yellowish, and the venter dark. It is common on willow in Europe, Siberia, and North America. It occurs in every Western State and extends along the Pacific Coast into Alaska.

The potato flea beetle, *Epitrix cucumeris* Harris, is 1.5–2 mm. long, oval-oblong, shining black, the antennæ and legs reddish, the dorsum finely punctured, and the elytra also striate. This is one of the most injurious flea beetles, occurring throughout the country and feeding on a great many plants, but preferring the solanums including the potato, nightshade, horse nettle, eggplant, tomato, pepper, ground cherry, petunia, tobacco, Jimpson weed, and wonderberry. It also feeds on apple, arbutus, ash, bean, beet, cabbage, carrot, celery, wild bird cherry, clover, corn, cucumber, dogbane, elder, holly, honeysuckle, hop, horse-chestnut, lettuce, maple, muskmelon, phlox, plantain, sweet potato, evening primrose, pumpkin, radish, raspberry, rhubarb, St. John's wort, sarsaparilla, sorrel, spinach, sumach, sunflower, turnip, viburnum, violet, and watermelon. It is a serious pest to potatoes and tomatoes, spreading blights and leaf spot in addition to the serious injury caused by the feeding of the larvæ on the tubers and roots, and the adults on the leaves. The larvæ are small white grubs which live in the soil and feed on the roots of various plants, often producing pimples on potatoes. There are one or two broods a year. The winter is passed in the adult stage. Control measures consist in the application of a combined Bordeaux mixture and arsenate of lead spray, using a 5–5–50 formula, and 1 pound of powdered arsenate of lead. **The western potato flea beetle,** *Epitrix subcrinita* Lec., is 2 mm. long, shining bronze, and somewhat resembles the preceding species in appearance and habits. It is recorded in the Western States of Arizona, Colorado, Montana, Utah, Nevada, California, Oregon, Washington, Idaho, and British Columbia. It is particularly injurious to potatoes and tomatoes but attacks a list of plants similar to those preyed upon by the preceding species. There are two generations, but the summer brood appearing in July and August is the most injurious. *Glyptina cerina* (Lec.) is 2–2.5 mm. in length and pale

[1] G. F. Mozenette, *P. C. Jour. Ent. and Zoöl.*, 9, p. 13, 1917.

reddish yellow with darker head. It is common on and destructive to potatoes in New Mexico, Arizona, and California.

The tobacco flea beetle, *Epitrix parvula* (Fabr.)[1] (Fig. 391), is 1.5–2 mm. long, oblong-ovate, reddish to dark brown, the elytra often with a dark median transverse band. The adults hibernate and appear in the spring and continue throughout the summer, there being at least two broods a year. They are most injurious to solanaceous plants such as tobacco, tomato, potato, ground cherry, horse-nettle, Jimpson weed, poha, spiny solanum, and eggplant, but also feed on almond, orange, squash, and other plants. This species occurs throughout the country and is recorded in Texas, New Mexico, Arizona, Nevada, and California, and probably occurs in other Western States. Control measures are the same as for the potato flea beetle.

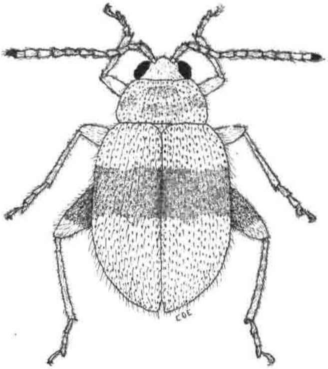

FIG. 391.—The tobacco flea beetle, *Epitrix parvula* (Fabr.).

The dock leaf mining beetle, *Mantura floridana* Crotch, is 2 mm. long, shining pale to chestnut brown, with the head and prothorax darker. The larvæ are whitish, with head, prothorax shield, and spots on the dorsum of the thorax, black. They mine the leaves of dock, often completely destroying them. Their transformation occurs in early spring. Leaves containing great numbers of mature larvæ were taken in the middle of March, 1924, by W. W. Jones at Prescott, Arizona, and by the last of the month adults were appearing. The species ranges throughout the east.

The toothed flea beetle, *Chætocnema denticulata* (Illiger), measures 2–2.5 mm., is irregular oval, slightly brassy, with portions of the antennæ and legs reddish, and densely punctured on the face. It feeds naturally on wild grasses and works over to corn, beets, and sorghums. It extends west into New Mexico, Colorado, Montana, Utah, and California. **The desert corn flea beetle,** *Chætocnema ectypa* Horn,[2] is 1.5 mm. long, metallic bronze, with the antennæ reddish at the base and black apically. It is typically a desert species breeding naturally on wild grasses and often seriously infesting corn, sugar cane, Sudan grass, barley, wheat, and alfalfa. The combined Bordeaux mixture and arsenate of lead as recommnded for the potato flea beetle greatly assist in the control of this species. The distribution includes Arizona and Southern California.

The banded flea beetle, *Systena tæniata* (Say) (*S. blanda* Melsh., *S. ligata* Lec.), (Fig. 392), is 3–4.5 mm. in length, shining pale yellow, brown, or blackish, with reddish brown head and prothorax, and a wide longitudinal paler stripe on the middle of each elytron. Even in the palest specimens, traces of the stripes are visible. The eggs are elliptical, 0.4 mm. long, a little over twice as long as wide, pale buff yellow, with finely granulated surface. They are laid singly or in small masses on the plants, usually near the

[1] F. S. Chamberlin and J. N. Tenhet, *Farmers' Bul.* 1352, U. S. Dept. Agr. 1923.
[2] V. L. Wildermuth. Bul. 436, Div. Ent. U. S. Dept. Agr. 1917.

ground, in the spring and early summer, and are attached by the sides. The small slender white larvæ 3 mm. long live in the soil and feed on the roots of plants. Pupation occurs in the soil. There are at least two broods a year. This species is one of the commonest and most injurious garden pests in the west and feeds on many plants such as alfalfa, beans, beets, carrot, clovers, cocklebur, corn, cotton, eggplant, grasses, Jimpson weed, lambsquarters, lettuce, melons, nightshade, oats, parsnips, peas, peanut, pear, pigweed, purslane, radish, sandbur, sunflower, tomato, turnip, strawberry, and wormwood, It ranges throughout the country and several forms are known in the west. The western distribution includes Colorado, New Mexico, Arizona, California, Nevada, and Utah.

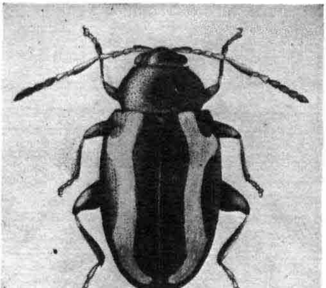

FIG. 392.—The banded flea beetle, *Systena tæniata* (Say). (Drawing by G. F. Mozenette.)

The Colorado cabbage flea beetle, *Phyllotreta albionica* (Lec.),[1] is 1.5–2 mm. long, elongate-oval, narrow, uniformly black, with a faint brassy lustre. It commonly infests cabbage, cauliflower, beet, horseradish, mustard, Rocky Mountain bee plant, and so forth, in New Mexico, Colorado, Montana, and west into Southern California.

The western flea beetle, *Phyllotreta pusilla* Horn,[2] is 1.5–2 mm. in length, narrow, elongate, dark shining olive green or blackish. It often occurs in swarms and greatly injures cabbage, cauliflower, horseradish, mustard, radish, rape, water cress, peppergrass, turnips, sugar beets, and corn in States on the east slopes of the Rocky Mountains and also in Texas, New Mexico, Colorado, Wyoming, Montana, Arizona, Utah, Nevada, and California. **The Oregon flea beetle,** *P. oregonensis* (Crotch) is 2.5–3 mm. long, robust, shining black with a brassy lustre. It has similar habits and occurs in Oregon, Nevada, and probably in the adjacent States.

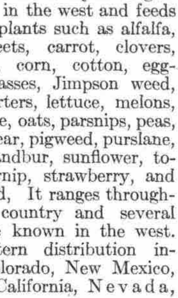

FIG. 393.—The western striped flea beetle, *Phyllotreta ramosa* (Crotch).

The western striped flea beetle, *Phyllotreta ramosa* (Crotch) (Fig. 393), is 2 mm. in length, elongate, shining black with brassy reflections and with a conspicuous, irregular yellow-white vitta on each elytron. It is often very abundant and de-

[1] C. P. Gillette, Bul. 24, Colo. Agr. Exp. Sta., p. 12, 1893.

[2] F. H. Chittenden and H. O. Marsh, Bul. 902, *Prof. Paper*. U. S. Dept. Agr. 1920.

structive to cabbage, cauliflower, brussels sprouts, radish, rape, mustard, stocks, turnips, wallflower, water cress, and other cruciferous plants in California.

The hop flea beetle, *Psylliodes punctulata* Melsh.,[1] is 2–2.5 mm. long, elongate-oval, and shining, metallic black or dull green. The eggs are minute, oval, yellow, and are laid on the stalks near the ground. The slender white grubs have dusky markings and average 5 mm. in length when full grown. They feed on the roots of hops and other food plants of the adults. The adults are particularly injurious to the leaves of hops and also feed on beets, cabbage, chickweed, clover, cucumber, dock, lambsquarters, mustard, nettle, potato, radish, rhubarb, sorrel, tomato, turnip, and watermelon. Young plants are often attacked just as they are coming up. The most serious injury has resulted to hops in British Columbia. The distribution embraces much of North America and includes every Western State from the Rocky Mountains to the Pacific, and from Mexico into British Columbia. Burning all plants and rubbish after harvest, clean culture, and tanglefoot bands around the poles are suggested measures of control in hop fields where spraying is usually too expensive.

The Arizona malva miner, *Stenopodius flavidus* Horn, is 4 mm. long, pale yellow above and black beneath. W. W. Jones has reported the larvæ mining and completely destroying the leaves of hollyhock and Arizona malva in Arizona. The species also ranges into Southern California. Jones also reports *Chalepus ater* Weise, an elongated black beetle with red thorax, mining the leaves of beans in Arizona and New Mexico.

The Argus tortoise beetle,[2] *Chelymorpha cassidea* (Fabr.) (*C. argus* Licht.), measures 9.5–11.5 mm., is oblong-oval, convex with head partially exposed, bright red, the pronotum with four or six black spots, and the elytra with 13 black spots. It feeds on wild and ornamental morning glory, moon flower, sweet potato, milkweed, cabbage, corn, plantain, raspberry, and so forth, and occurs throughout the east, ranging west into Colorado, New Mexico, Arizona, Utah, and Washington.

The black-legged tortoise beetle, *Jonthonota nigripes* (Oliv.) (*Cassida*), is 6–7.5 mm. long, broadly ovate, the head completely hidden from above, dull red or golden, each elytron with three obscure dark spots near the middle, and the venter and legs black. The broad flattened larvæ are straw yellow, margined and covered with long, coarse black-tipped spines, and with two long black areas on the dorsum. They are often partially hidden by the mass of excrement and debris carried on the fæci fork over the back. They feed chiefly on wild morning glory but also attack sweet potato, moon flower, and related plants. The species ranges from the east into New Mexico, Colorado, Arizona, Nevada, and California. The California specimens have been referred to the variety *novemmaculata* (Mann.).

The eggplant tortoise beetle, *Gratiana pallidula* (Boh.) (*Cassida, C. texana* Crotch),[3] is 5 x 3.5 mm., oval, flattened-convex, the head completely hidden from above, dull green, the dorsum coarsely punctured, the punctures often grayish or dark. The members hibernate and appear in the spring, depositing the small white eggs singly or in groups of three or four on the leaves. The eggs are covered with a thin membrane and turn pale brown soon after they are laid. The pale greenish, flattened larvæ are about the same size as the adults and often so closely match the color of the host plant as to be difficult to detect. The larvæ and adults perforate the leaves with small holes and may entirely kill all of the foliage. There

[1] W. B. Parker, Bul. 82. pt. 4, Bur. Ent. U. S. Dept. Agr. p. 33, 1910.

[2] H. S. Barber, "Review of N. A. Tortoise Beetles." *Proc. Ent. Soc. Wash.*, 18, p. 113, 1916.

[3] T. H. Jones, Bul. 422. *Prof. Paper*, U. S. Dept. Agr. 1916.

are several broods a year, although in California the spring brood in May is by far the most injurious to native nightshades. Eggplant, tomato, potato, and related plants are also infested. The species occurs in Mexico and ranges north into the Southern and Middle States, and into Texas, New Mexico, Arizona, and Southern California. In California the attacks so far have been largely confined to nightshade.

The beet shield beetle, *Cassida nebulosa* Linn.,[1] has been recorded as injurious to beets in Southern California in 1894, but has not appeared since in noticeable numbers.

The golden tortoise beetle, *Metriona bicolor* (Fabr.) (*Coptocycla, C. aurichalcea* Fabr.) (Fig. 394), is like a drop of burnished gold and the adults are often designated as "gold

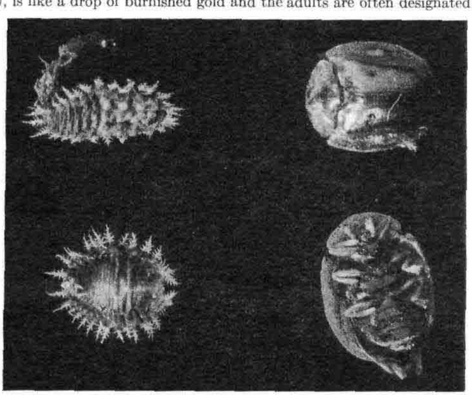

FIG. 394.—The golden tortoise beetle, *Metriona bicolor* (Fabr.). Larva with fecal mass at upper left.

bugs." They are 5 mm. long, broadly oval with the head completely hidden, golden in color, with three small black dots on each elytron. The eggs are irregular, flat, 1 mm. long, often with three spine-like projections at the larger end. The larvæ or "peddlers" are dull brown, spiny, and carry the characteristic fecal mass over their backs, possibly as a means of protection. They feed normally on morning glory, but are often found on sweet potato and related plants, while the adults may be found resting on many kinds of plants. The species occurs throughout the continent and is frequently collected in all parts of California. *Deloyala clavata* (Fabr.) (*Coptocycla*) is a large, broadly oval, reddish brown species with pale prothoracic margins and sides, the apices of the elytra pale, and the elytra covered with small tubercles. It ranges west into New Mexico and Arizona and has caused injury to chili peppers.

MYLABRIDÆ (*Bruchidæ*).[2] Bean Weevils. Pea Weevils. (Not true weevils).

[1] Geo. H. Horn, *Ent. News*, 5, p. 146, 1894.

[2] Geo. H. Horn, "Rev. of *Bruchidæ* of U. S." *Trans. Am. Ent. Soc.*, 4, p. 311, 1873. R. A. Cushman, "Hosts and Parasites of *Bruchidæ*." *Jour. Econ. Ent.*, 4, p. 489, 1911. E. A. Back and A. B. Duckett, "Bean and Pea Weevils." *Farmers' Bul.* 983. U. S. Dept. Agr. 198.

The bean weevil, *Mylabris obtectus* (Say) (*Bruchus, Acanthoscelides*), is 2–3 mm. in length, robust, somewhat triangular, almost flat dorsally, velvety gray or brown with pale linear markings on the elytra which are truncate and do not cover the tip of the abdomen; the legs are red. The tiny white eggs are laid on the beans and hatch in from 5–20 days into tiny white, legless grubs which at once enter the bean and begin to feed on the inside, the entrance hole being so small as to remain obscure. The grubs become full grown in 11–42 days and are robust, white, slightly curved, and 5 mm. long. Pupation occurs within the beans and requires 5–18 days. The adults cut a disc in the outside skin through which to emerge. A complete life cycle requires from 21–80 days according to the season and locality. Breeding continues in storage and generation after generation follows until the beans are completely eaten up. Warm, damp storage places favor development, while cold, hot or dry places retard growth. The adults hibernate in the fields and warehouses and are usually on hand at harvest time. Practically all varieties of beans are infested, including bush limas and, rarely, large limas; 20 or 30 larvæ may be found in a single large bean. They also feed on cowpeas, peas, lentils, and so on, to some extent.

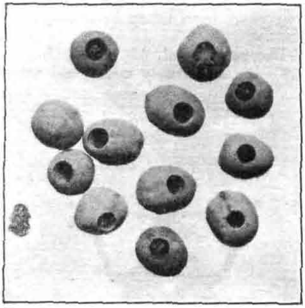

FIG. 395.—The pea weevil, *Mylabris pisorum* (Linn.). Adults and exit holes in peas.

The bean weevil is cosmopolitan and now occurs wherever beans are produced, but is most serious in the warmer regions. The larvæ and pupæ are preyed upon by the ventricose mite, *Pediculoides ventricosus* (Newp.), which is often a formidable enemy, and are parasitized by internal parasites.

Control measures consist in the following:

1. Harvesting just as soon as possible to prevent infestation in the fields. Beans which are allowed to remain a long time in the fields after ripening are almost sure to become infested.
2. Store in a clean, dry, light storehouse.
3. Infested beans can be freed of the weevil by fumigating in an air-tight container with from 3 to 10 pounds of carbon disulfid to 1,000 cubic feet of air space. Carbon tetrachlorid is often preferred because it is non-inflammable and non-explosive, but should be used in double the quantity of carbon disulfid.
4. Heating to 145° F. for two hours kills all stages.
5. Cold storage at a temperature of 32° to 34° F. prevents development of the weevil, but does not injure germination.

After treatment, it is necessary to keep the beans free from weevils in order to prevent reinfestation. Beans held in storage for more than the one

season nearly always become infested and are a source of infestation for the new crop.

The four-spotted bean weevil, *Mylabris quadrimaculatus* (Fabr.) (*Bruchus*), is 2.5–3 mm. long, slender, reddish brown with pronotum largely black and gray or with reddish spaces separating 4 or 5 dark spots or areas on the dorsum and usually three on the truncate elytra and two on the exposed tip of the abdomen. The minute, flat white eggs are pointed at one end. This species is cosmopolitan and most abundant in the southern warmer States, being a continuous breeder in blackeye beans and cowpeas. It has frequently been taken in warehouses in California. For control see the bean weevil.

The pea weevil, *Mylabris pisorum* (Linn.) (*Bruchus, Laria*) (Figs. 395, 396), is considerably larger and more robust than the preceding species,

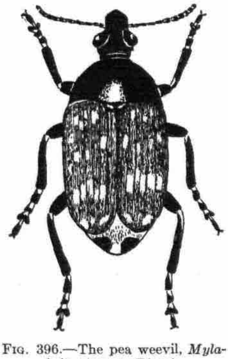

FIG. 396.—The pea weevil, *Mylabris pisorum* (Linn.).

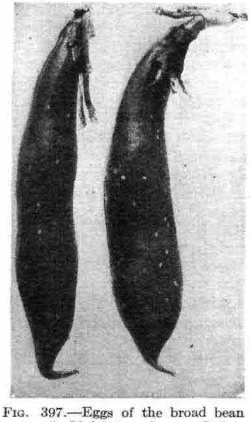

FIG. 397.—Eggs of the broad bean weevil, *Mylabris rufimanus* (Boh.), on pods of broad beans. (Photo furnished by F. H. Wymore.)

being 4.5–5 mm. long. with the sides almost parallel, black or brownish with a distinct spot of white scales at the median base of the pronotum, small white patches and a zigzag white line across the elytra just behind the middle, and a large white patch on the exposed portion of the abdomen. The adults hibernate and appear on the vines when the latter begin to bloom, gluing the small yellow eggs singly on the green pods. The minute larvæ, upon hatching, make their way through the pod and into the centre of the developing peas where they remain feeding on the inside. By the time the seeds reach maturity the entrance hole is obscured and no evidence of infestation is manifest. Development continues until fall when maturity

is reached, but the adults remain in the peas until the following spring when they emerge through the characteristic round hole. Usually but a single grub is found in a pea. Unlike the bean weevil, the species cannot reproduce in dry peas, so there is but a single generation a year and infestation always takes place in the field while the peas are still green. Only clean seed should be planted. Rotation of crops may be necessary to rid the fields of the hibernating adults which pass the winter largely in shelled peas on the ground or in straw and rubbish. The use of hogs or poultry after harvest will eliminate most of these. This weevil is cosmopolitan and occurs wherever peas are grown commercially.

The broad bean weevil, *Mylabris rufimanus* (Boheman) (*Bruchus, Laria*) (Figs. 397, 398), is 3–4 mm. long, or about the same size as the

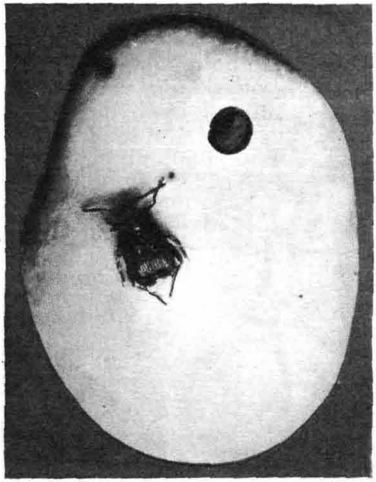

FIG. 398.—The broad bean weevil, *Mylabris rufimanus* (Boh.), and exit hole in broad bean.

pea weevil, but much darker, being black with scattering white scales in a more or less definite pattern on the dorsum. Its life history is much the same as that of the pea weevil, but it infests the broad bean which is also called the horse, Windsor, or tick bean, and is often a serious pest to this crop in California. It is a European species. Cleanliness in the fields, early harvesting and bagging in the fields are important control measures.

The white scutellum weevil, *Mylabris alboscutellatus* (Horn) (*Bruchus*), is 2.5 mm. in length, black with quadrate white spots on the elytra, and a round white scutellum.

It infests the capsules of water purslane in the east and the seeds of wild licorice in New Mexico. *Mylabris fraterculus* (Horn) is 2–3 mm. long, black, or slightly pruinose.

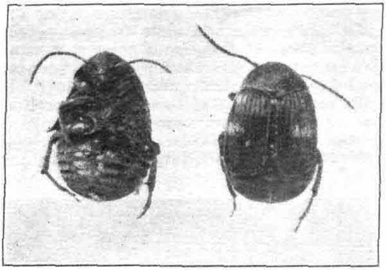

FIG. 399.—Adults of the Mexican bean weevil, *Zabrotes pectoralis* Sharp.

It infests the seeds of wild licorice, and hedysarum in Colorado, California, and New Mexico. **The amicable weevil,** *Mylabris amicus* (Horn), infests the seeds of the screw

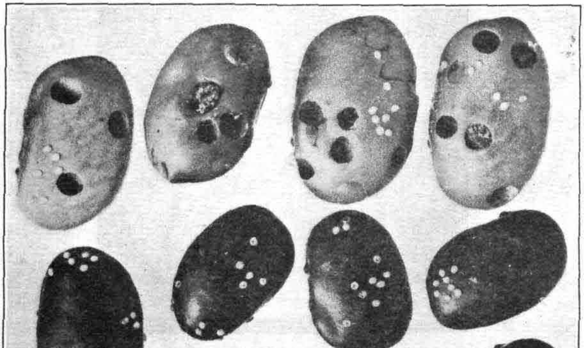

FIG. 400.—Eggs and exit holes of Mexican bean weevil, *Zabrotes pectoralis* Sharp.

bean or tornillo in Texas and New Mexico. **The desert weevil,** *Mylabris uniformis* (Lec.) (*Bruchus desertorum* Lec., *B. prosopis* Lec.), is 2–5 mm. long, pale to dark reddish,

with yellowish or whitish pubescence, and often with darker brown markings on the margins of the elytra. It is a common destructive species breeding in the seeds of mesquite, screw bean or tornillo, and false indigo in Mexico, Texas, New Mexico, Arizona, and Southern California. **The limbate weevil,** *Mylabris limbatus* (Horn), is 2.5–3 mm. long and dull gray with eight brown stripes on each elytrum. It infests the seeds of teneza (*Siderocarpus*) and guamuchile (*Pithecolobium*) in Mexico, Texas, New Mexico, Arizona, and Southern California. *Mylabris protractus* (Horn) is 4 mm. long, pale reddish brown, the elytra with lateral black spots. It infests the seeds of mesquite in Mexico, Texas, New Mexico, Arizona, and California. **The pruinose weevil,** *Mylabris pruininus* (Horn), is 2–3 mm. in length, robust, oval, black and usually covered with brown, with a gray spot on the pronotum and one on each elytron. The

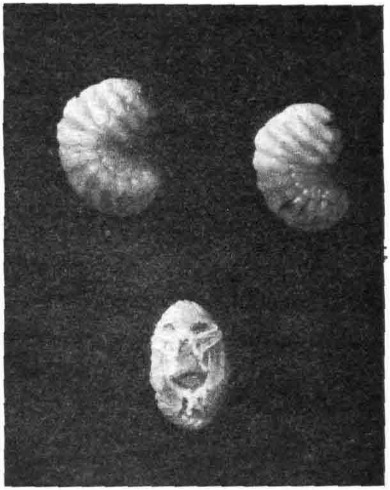

FIG. 401.—Larvæ and pupa of the Mexican bean weevil, *Zabrotes pectoralis* Sharp.

adults frequent flowers and feed on pollen. It is a common and often abundant species in Texas, New Mexico, Arizona, and California. The larvæ breed in the seeds of acacia, desert ironweed, black locust, cassia, desmanthus, albizzia, red Mexican beans, and soybeans. **The ratama weevil,** *Mylabris ulkei* (Horn), is black with white pubescence, the elytra with a broad space on each side black. It breeds in the seeds of ratama in Arizona.

The wild grape seed weevil, *Spermophagus vitis* Schaeffer, is 4 mm. long, oval, reddish brown, and clothed with pale hair. It breeds in the seeds of wild grape in Arizona.

The Mexican bean weevil, *Zabrotes pectoralis* Sharp (*Spermohagus*)[1] (Figs. 399, 400, 401), is 1.5–2 mm. long, pale or dark brown or black with an interrupted white line across the middle of the wing covers, a median

[1] E. O. Essig, *Mthly. Bul.*, Cal. State Dept. Agr. 10, p. 140, 1921.

white spot at the posterior of the prothorax, and with two spines at the tips of each tibia. The eggs are disc-like and laid on the outside of the infested beans and are very conspicuous, particularly on the black and red Mexican beans which are often very seriously infested. Apparently all varieties of common beans are attacked. The weevil works in stored beans as does the common bean weevil and is a very serious pest. It occurs in Mexico and Texas and has been received into California in beans from the latter State, although it does not appear to be established along the Pacific Coast. Control measures are the same as for bean weevil.

RHYNCHOPHORA[1] (Series VII). WEEVILS, SNOUT BEETLES, CURCULIOS

Coleoptera with head prolonged into a beak

KEY TO FAMILIES

1. Beak abortive or extremely short and broad; antennæ short with large club; tibiæ often with several external teeth; small oval or cylindrical brown or black beetles 2
   Beak well developed; antennæ without or with but a small club; tibiæ without external teeth........ 3

2. *First tarsal joint as long as others together; head wider than the prothorax;* eyes rounded........ **Platypodidæ** p. 509
   First tarsal joint shorter than the combined length of the others; head narrower than the prothorax; eyes oval, emarginate or divided. (Barkbeetles.)...... (*Ipidæ*) **Scolytidæ** p. 510

3. Antennæ usually elbowed with the basal joint greatly elongated; palpi small, short, rigid, and nearly always concealed within the mouth; beak often curved downwards. (Weevils.) (Including **Rhinomaceridæ, Rhynchitidæ, Attelabidæ, Brysopidæ, Otiorhynchidæ, Calandridæ.**)........ **Curculionidæ**
   Antennæ not elbowed; palpi usually exposed........ 4

4. Prothorax elongate, elytra covering the pygidium, first two ventral abdominal segments fused; beak short and broad........ (*Anthribidæ*) **Platystomidæ**
   Prothorax not elongate, usually trapezoidal; pygidium exposed; ventral abdominal segments free; beak very long in the female, sometimes entirely absent in the male........ **Brenthidæ**

CURCULIONIDÆ. Curculios, Weevils, Snout Beetles, etc.

In this family have been grouped all of the common weevils previously listed in a number of families which are herein designated as subfamilies, following the classification of C. W. Leng in the Catalogue of Coleoptera.

RHYNCHITINÆ (Subfamily). The Toothed Nose Snout Beetles. **The rose snout beetle or rose curculio,** *Rhynchites bicolor* Fabr. (*Merhynchites*) (Fig. 402), is 5–6.5 mm. in length, robust, black, with the elytra, pronotum, and the posterior portion of the head bright red, the beak is as long as the head, the head and prothorax much narrower than the elytra. The above form is the typical eastern species. A number of western color phases are recognized as follows:[2] *wickhami* Ckll. has only the elytra and pronotum red and ranges in New Mexico, Colorado, Wyoming, Montana, Idaho, Utah,

[1] J. L. Leconte and Geo. H. Horn, "*Rhynchophora* of America, North of Mexico." *Proc. Am. Philos. Soc.*, 15, p. 1, 1876.
W. D. Pierce, "Miscellaneous *Attelabidæ*." *Proc. U. S. Nat. Mus.*, 45, p. 365, 1913; "Studies in N. A. Weevils." *Proc. U. S. Nat. Mus.*, 57, p. 325, 1910.
W. S. Blatchley and C. W. Leng, *Rhynchophora or Weevils of N. E. America.* Nature Pub. Co., Indianapolis, 1916. (Complete Bibliography.)
[2] W. D. Pierce, *Proc. U. S. Nat. Mus.*, 45, p. 370, 1913.

Arizona, California, Nevada, Oregon, Washington, and British Columbia; *cockerelli* Pierce is all red excepting the venter of the meso- and metathorax and abdomen which are black; it is recorded in Utah, Idaho, and California; *piceus* Pierce is entirely black with a greenish lustre and occurs in Oregon; *viridilustrans* Pierce is black with a blue-green lustre and occurs in Arizona. All forms feed on wild and cultivated roses. The adults drill small round holes deep into the buds and hips for feeding and egg-laying. When the petals unfold they are completely perforated with numerous small holes. Eggs are usually laid in the hip or ovary and the small white larvæ feed in the seed pods. Pupation and hibernation occur in the soil. The flowers of blackberry and raspberry are also often seriously injured by the adults. The species occurs throughout the entire west and normally breeds in thimbleberry and wild roses. Some very good results in control were obtained by the writer in dusting infested roses with 5 per cent nicodust. *R.*

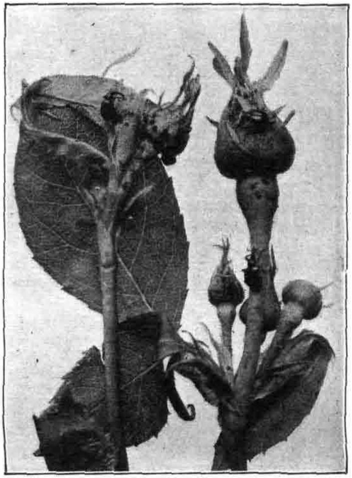

FIG. 402.—The rose snout beetle, *Rhynchites bicolor* Fabr., and punctures in rose buds.

æneus Boh. is 5–6.5 mm. long, wholly black with a faint bronze tinge, or with dull brownish yellow elytra. It feeds on artichoke, wild sunflower, and psoralea in the east, and is recorded in New Mexico and Oregon in the west. It is easily confused with the dark form of the preceding species. *R. æratoides* Fall is 2–2.5 mm. long, brassy black beneath and coppery above and is characterized by a longitudinal median impressed line on the first three ventral segments of the male. It occurs on wild buckwheat in Southern California. *R. cyanellus* Lec. is 2.4–2.7 mm. long, black, with the dorsum metallic bluish green. It feeds on willow throughout the east, ranging west into Colorado. *R. eximius* Lec. feeds on *Thelesperma gracile* Gray in Colorado and Arizona. *R. mexicanus* Gyllenhal feeds on *Eucillia* sp. in New Mexico and Mexico. *R. naso* Casey is a very small blue-black species which occurs on California juniper in California.

The live oak weevil, *Deporaus glastinus* Lec., is 3–4 mm. in length, metallic dark blue-green, thickly clothed with short stiff black hairs, and of much the same shape as the preceding species. It is often abundant on live oaks and also attacks plums. It is recorded in Colorado, Arizona, California, and Washington.

APIONINÆ[1] (Subfamily). The Apion Weevils. **The deer weed apion,** *Apion porosicolle* Gemm. (*A. cribicolle* Lec., *A. brevicolle* Smith), is 2–2.5 mm. long, robust, and black with a bronze lustre. It feeds on deer weed, wild buckwheat, and has been taken on olive trees. The range includes California, Oregon, and Utah. **The lupine weevil,** *Apion proclive* Lec., is 2–2.6 mm. long, black with or without a brassy lustre, and pubescent. It breeds in the pods of tree and other lupines and is common in New Mexico, Colorado, Wyoming, Utah, California, and Oregon. *A. sordidum* Smith is 1.5–2.2 mm. long, black, and breeds in cecidomyid galls on artemisia in California, and galls on the stems of hymenoclea in Arizona. It also occurs in Utah.

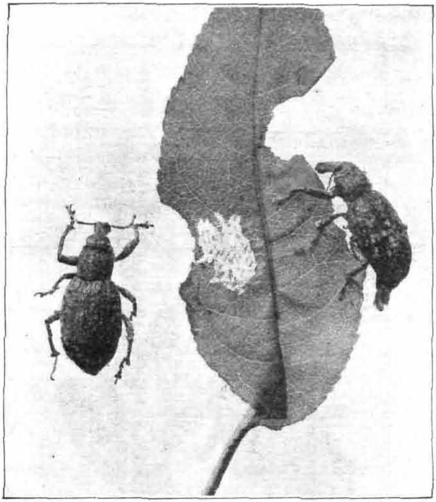

FIG. 403.—The adaleres, *Adaleres ovipennis* Casey, and mass of eggs laid in confinement.

OTIORHYNCHINÆ (Subfamily). The Scarred Snout Weevils. **The white bud weevil,** *Eupagoderes geminatus* Horn, measures 7–12 mm., is entirely covered with white scales, and has three brown longitudinal lines on the pronotum and three on each elytron. The abdomen is large and rounded. It is a desert species in Nevada and California, and normally feeds on sage brush but also severely injures developing buds of fruit trees in the early spring on the east foothills of the Sierras. *E. mortivallis* Fall is similar in appearance and habits and is recorded from Southern California.

The adaleres, *Adaleres ovipennis* Casey (Fig. 403), is 10–15 mm. in length, brown with a scattering of gray scales on the dorsum, and wingless. The eggs are cylindrical, somewhat bent in the middle, and shining white. In captivity, they have been ob-

[1] J. B. Smith, "Syn. *Apioninæ* of N. A." *Trans. Am. Ent. Soc.*, 11, 1884, p. 41.
H. C. Fall, "Rev. of the Species of *Apion* of America North of Mexico." *Trans. Am. Ent. Soc.*, 25, p. 105, 1898. "New North American Species of *Apion*." *Jour. N. Y. Ent. Soc.*, 26, p. 218, 1918.

served to be laid in a mass on a leaf. The normal hosts are live oak and ceanothus but the adults are often very destructive to foothill orchards by destroying the buds in the early spring and the leaves during the early summer. Almond trees have been so injured in San Luis Obispo County and prune trees, in Lake County, California. **The scrub oak weevil,** *Polydrusus ochreus* (Fall) (*Cyphomimus*), is 3.6 mm. long, and reddish brown in color. It is common and often abundant on scrub oak in New Mexico.

Members of the genus *Scythropus* are medium-sized, slender, somewhat cylindrical species, usually with a metallic lustre and variable in color. They occur in the mountains and feed on pine needles producing saw-tooth edges. **The elegant pine weevil,** *S. elegans* (Couper), is 5–7 mm. long, metallic bright green, brass, bronze, or combinations of these colors, and often gold, brass, or bronze with a green humeral stripe. It is a boreal species ranging in the northern part of North America and common in the higher altitudes of Montana, Washington, California, and probably other Western States. *S. albidus* Fall is entirely of an ashy white color with a faint greenish lustre, and occurs in Northern California, Oregon, and Idaho. *S. californicus* Horn is mottled black with reddish legs. It is recorded in New Mexico, Arizona, California, Nevada, Oregon, Washington, and British Columbia. *S. ferrugineus* Casey is mottled rusty red throughout and occurs in California and Oregon. *S. miscix* Fall is black with legs black in the males and reddish in the females. It is known in California, Washington, and Montana.

The imbricated snout beetle, *Epicærus imbricatus* Say, is 12 mm. long, and brownish gray with two pale zigzag lines across the elytra. It feeds on a large number of plants, being injurious to apple, blackberry, cabbage, cherry, clover, corn, cucumber, gooseberry, grasses, muskmelon, onion, peas, potatoes, raspberry, squash, sugar beets, watermelon, and weeds. It occurs throughout much of the United States and extends west into New Mexico, Arizona, Colorado, and Utah.

Fuller's rose weevil, *Pantomorus godmani* (Crotch)[1] (*Aramigus fulleri* Horn)[2] (Fig. 404), is 7–9 mm. in length, nearly uniform pale brown, faintly pruinose, and with a white oblique stripe on each side of the elytra; wingless; the rostrum short and broad. The eggs are ovoid or elliptical, pale yellow, smooth, about 1 mm. long, and laid in irregular rows in masses of from 10 to 60 in the cracks, under the bark of trees or near the bases of smaller plants, or on the ground near the host in the spring of the year. The larvæ are white, legless grubs 5 mm. long and live on the roots of plants in the soil. Pupation occurs in a small cell in the ground. The adults hibernate and appear often in large numbers in the spring and feed on a variety of plants including abutilon, acacia, achyrantes, alfalfa, apple, apricot, azalea, common and lima beans, begonia, blackberry, camellia, cannas, cape jasmine, carnations, cissus, citron, chrysanthemum, currant, deutzia, dræcæna, feijoa, fuchsia, gardenia, geraniums, golden glow, grapefruit, hibiscus, leadwort, lilies, lemon, oaks, orange, palms, peach, pear, pentstemon, persimmon, plum, plumbago, prune, primrose, potato vine, raspberry, roses, scabiosa, strawberry, sugar cane, tangerine, and vinca, while the larvæ feed chiefly on the roots of blackberries, loganberries, raspberries, roses, and strawberries. The adults are thought to spread citrus blast in the orange groves of northern California. The species ranges throughout much of North America, and is very common in California and is also recorded in Montana in the west. As the adults cannot fly they can be kept from ascending shrubs and trees by means of a cotton, tin, or tanglefoot band, providing the branches are pruned so as not to touch the ground. Arsenate of lead, two pounds of the powder to 50 gallons of water, is recommended when the bands cannot be used.

[1] G. C. Champion, *Entom, Mthly. Mag.*, 58, p. 161, 1922.
[2] F. Maskew, Bul. 44, Bur. Ent. U. S. Dept. Agr., p. 46, 1904.

The strawberry root weevil, *Brachyrhinus ovatus* (Linn.) (*Otiorhynchus*),[1] measures 4–6 mm., is shining black with reddish brown antennæ and legs, the surface coarsely punctate and somewhat hairy, and the elytra finely striate. The adults are wingless and hibernate in the crowns of the strawberry plants or under leaves and refuse in the fields. They appear in June

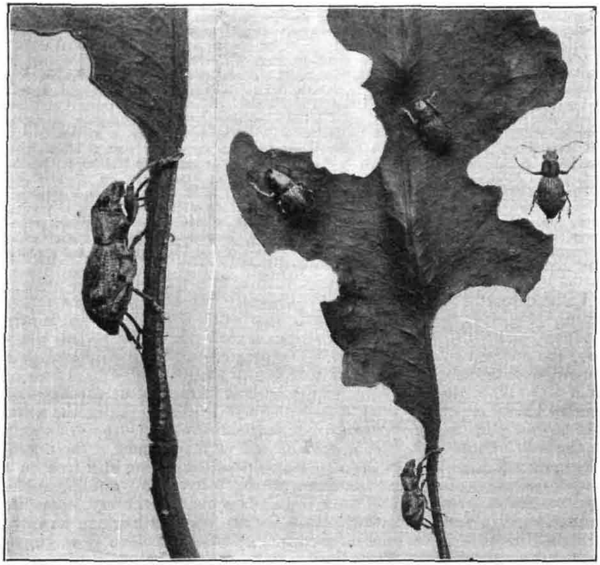

FIG. 404.—Fuller's rose weevil, *Pantomorus godmani* (Crotch), and work of adults on lemon leaves.

and lay about 50 eggs each. Egg laying requires from 4 to 15 days and is usually completed by the last of August. The weevils feed at night on the leaves and fruit of the strawberry, raspberry, grape, apple, peach, and so forth, but are not nearly as injurious as the larvæ. There are two migrations, the first during the egg-laying period from the last of June to

[1] E. P. Venables, *Proc. Ent. Soc. B. C.*, p. 11, 1912.
H. F. Wilson, *First Bien. Crop Pest and Hort. Rept.* 1911–1912. Ore. Agr. Exp. Sta., pp. 80, 122, 1913.
R. C. Treherne, Bul. 18, 2d ser., Div. Ent. Dom. Canada Dept. Agr. 1914. (Complete.) *Proc. Ent. Soc. B. C.* No. 4, p. 19, 1914.
A. L. Melander and M. A. Yothers, Bul. 136, Wash. Agr. Exp. Sta. 1917.

the first of September and the second in the fall, possibly for hibernation. The small white larvæ live in the soil to a depth of 8 inches below the surface and feed on the roots of the plants. They are most destructive in the spring when nearly full grown for then they attack and often sever the main roots, although they normally feed on the epidermis in a spiral manner. Maturity is reached in seven months, pupation occurring in May and June. The young larvæ appearing in the fall feed chiefly on the smaller roots and the tips of the larger roots. They pass the winter in the soil so that both larvæ and adults hibernate. The larvæ attack the roots of wild and cultivated strawberries, clover, dock, grasses, potentilla or five finger, rhubarb, timothy, and young nursery stock of Douglas fir, maple, juniper, and pines. This insect is the most serious pest to strawberries in the northwest, particularly in British Columbia, Washington, Idaho, and Oregon, and occurs also in Wyoming, New Mexico, and various States in the east as well as in Europe. It goes under a number of common names such as the strawberry root girdler, the pitchy-legged otiorhynchus, the sleepy weevil, and graveyard bug. Control measures are summarized as follows:

(1) grow strong varieties of strawberries,
(2) allow poultry to run in the patches after harvest,
(3) trap adults under piles of straw, boards, or on sticky shields,
(4) spray with arsenate of lead, two pounds of the powder to 100 gallons of water, as soon as the first crop is harvested and while the weevils are abundant,
(5) clean up and burn old leaves and refuse in the fields,
(6) plow in the fall,
(7) renew plants the middle of the second summer, using one-year crops instead of two.

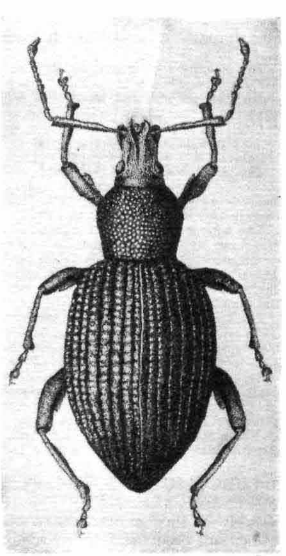

FIG. 405.—The black vine weevil, *Brachyrhinus sulcatus* (Fabr.). (Drawing by G. F. Mozenette.)

The black vine weevil or cyclamen borer, *Brachyrhinus sulcatus* (Fabr.) (*Otiorhynchus*) (Fig. 405), is 8.5 mm. in length, oblong, brownish black, pronotum densely tuberculate, elytra coarsely punctured and striate and with scattering yellow or golden scales. The adults are nocturnal and feed on maidenhair ferns, rhododendron, and many other plants. The white legless larvæ are 10 mm. long when mature. They live in the soil and feed on the roots of ampelopsis, blackberries, cranberries, cyclamen, gloxinia, primroses, raspberries, spiræa, strawberries, tuberous begonias, and wistaria.

The species is not nearly as injurious to strawberries as the preceding one. A. L. Melander reports it to be a serious pest to cranberries in the bogs of southwestern Washington.[1] *It is a European species now distributed in* many parts of North America and known to occur in California, Oregon, Washington, and British Columbia in the west.

The rough strawberry weevil, *Brachyrhinus rugifrons* (Gyll.) (*Otiorhynchus*), is very much like the preceding species, but is smaller and more rounded posteriorly. It is injurious to the roots and crowns of strawberries in British Columbia, Washington and Oregon, but little is known concerning its exact status as an economic insect. A single infestation in Alameda County, California, is believed to have been exterminated in 1920. It appears to be most serious in older plantings. Blackberries and raspberries are also attacked. It is a European and Asiatic species first introduced into the eastern part of North America.

The obscure root weevil, *Sciopithes obscurus* Horn, is a small grayish brown species 5–7 mm. long with a dark, white bordered irregular line marking off the dorsum of the elytra; the margins and apex thus separated are paler. The adults are common in alfalfa fields and the larvæ have been taken on the roots of strawberries by H. S. Smith in California. The adults feed on the leaves of the strawberries and have been observed *to be injurious to the opening buds and new foliage of fruit trees in Oregon* by H. F. Wilson. The weevil occurs in California, Oregon, Washington, and British Columbia.

The artemisia weevil, *Cercopeus artemisiæ* Pierce, is 3–3.5 mm. long, black, and covered with white or yellowish scales intermixed with short stiff hairs. It normally feeds on artemisia but also attacks buds and foliage of apple, cherry, and other fruit trees in Oregon, Montana, and British Columbia.

The apricot leaf weevil, *Paraptochus sellatus* (Boh.) (*P. californicus* Seidl.), is 3.5–5 mm. long, *uniformly dark brown with two faint white oblique lines on the sides of the* elytra, which are punctured, striate, and clothed with short stiff black and white hairs. The adults often appear in great numbers in the spring and feed on the buds and leaves of apple, apricot, prune, and other fruit trees in California and Oregon and range into British Columbia.

The small gray leaf weevil, *Thricolepis inornata* Horn, is 3–5 mm. in length, the body dark, but almost entirely covered with white scales except the dorsum which is mottled black and gray. *The antennæ and legs are rufous and the body is clothed with short* stiff dark hairs. The normal food of the adults appears to be various live and deciduous oaks, but they have been taken from alfalfa, clover, almond, peach, plum, and prune. The buds of the fruit trees are often seriously injured in the spring. The species is known in New Mexico, Colorado, Arizona, Utah, California, Oregon, and Washington. *Geoderces incomptus* Horn is 5–7 mm. long, a robust, blackish species taken on strawberries in Washington in 1923 by M. J. Forsell. It also occurs in British Columbia and ranges south to San Francisco, California.

CURCULIONINÆ (Subfamily).[2] Curculios. **The clover root curculio,** *Sitona hispidulus* (Fabr.) (*Sitones*),[3] measures 3–5 mm., is shining black, densely clothed above with coppery and grayish scales giving a grizzly color, and beset with short, rigid grayish hairs. The adults emerge from hibernation in May and June and deposit the eggs on the undersides of the leaves of clover, alfalfa, blue grass, and other wild grasses. They feed on the leaves, particularly on the margins. The young white legless grubs

[1] *Insect Pest Survey Bul.*, Bur. Ent. U. S. Dept. Agr. 2, No. 6, p. 209, 1922.

[2] Wm. G. Dietz, "Revision of the Genera and Species of *Ceutorhynchini* of N. A." *Trans. Am. Ent. Soc.*, 23, p. 388, 1896.

W. D. Pierce, *Proc. Ent. Soc. Wash.*, 21, p. 21, 1919.

[3] V. L. Wildermuth, Bul. 85, pt. 3, Bur. Ent. U. S. Dept. Agr. 1910.

F. M. Webster, *Farmers' Bul.* 649, U. S. Dept. Agr. 1915.

feed on the small tender roots and the mature larvæ eat large holes and grooves in the larger roots. A complete life cycle requires about 40 days and there are two broods annually. Crop rotation is the best means of control. This weevil occurs in Europe, Siberia, and many parts of North America, being known in British Columbia, Washington, Idaho, Oregon, Colorado, Utah, and California in the west. In Idaho it is often mistaken for the alfalfa weevil from which it may be distinguished by the smaller size and the broader snout. E. C. Van Dyke first reported it on white clover in California in 1917.[1]

The clover leaf weevil, *Hypera punctata* (Fabr.)[2] (Fig. 406), is 5–10 mm. long, oval, robust, black or dark brown, with venter, sides, and longitudinal dorsal stripes whitish, gray, or yellowish. The body is hairy and the surface has a metallic lustre. The small oval eggs are slightly over 1 mm.

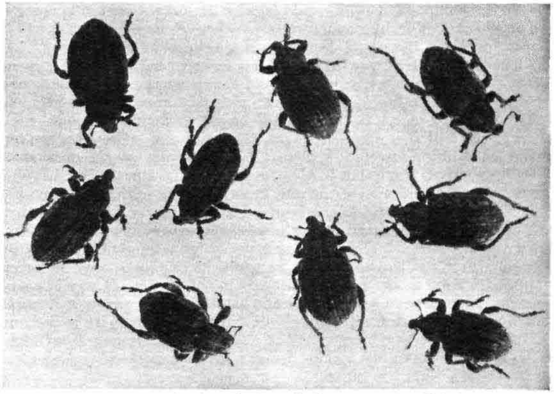

FIG. 406.—The clover leaf weevil, *Hypera punctata* (Fabr.).

long and hexagonally sculptured, first yellow, turning orange, and finally black. Oviposition occurs in September and October. The eggs are inserted in punctures in the stems, each female depositing from 200 to 300. Most of them hatch very quickly, but some remain until spring. The mature larvæ are 8–14 mm. long, legless, rough, dark green, head and anal segment dark brown, a dorsal longitudinal white line running the full length of the body, and dark brown or blackish lines below the spiracles on the sides. They pass the winter in an immature condition in the soil. During the night they ascend the plants and feed on the leaves and young tender stems of white and red clover, alfalfa, beans, and so forth, and are

[1] *Mthly. Bul.*, Cal. State Dept. Agr. 6, p. 248, 1917.

[2] E. G. Titus, *Ann. Ent. Soc. Am.*, 4, p. 396, 1912.
D. G. Tower and F. A. Fenton, Bul. 922, *Prof. Paper*, U. S. Dept. Agr. 1920.

often quite destructive. Pupation occurs in net-like tubes or cocoons made up of threads of a brown viscous material which, according to F. Knab,[1] comes from the Malpighian tubes through the anus from whence they are drawn with the mouth parts. They may also spin from a labial spinneret. The cocoons are oval, 9–10 mm. long, and occur in the soil or among the dead leaves and stems about the crowns of the plants. Pupation requires from 2 to 3 weeks and the adults emerge from early May to the middle of July. They also feed at night but may be readily swept from infested alfalfa and clover during the day. These pests may completely strip the plants of their leaves. Timothy and Jerusalem artichoke are also eaten by the adults. There is but one brood a year. This weevil is of European or Siberian origin and occurs in many parts of boreal North America, and is recorded in the west in Idaho, British Columbia, Washington, Oregon, and California. The fungus, *Entomophthora sphærosperma* Fres. (*Empusa*), kills pupæ and adults and plays an important part in keeping the weevil in check. The hymenopterous parasite, *Bathyplectes exiguus* Gravenhorst,[2] occur in the east. For control see the alfalfa weevil.

The lesser clover leaf weevil, *Phytonomus nigrirostris* (Fabr.) (*Hypera*).[3] is 3.5–4.5 mm. in length considerably smaller than the preceding species, and reddish brown to black, clothed with greenish, gray, or yellowish short stiff hairs. Western adults are usually green with black snout, brown head and legs, and two pale stripes on the pronotum. The eggs are oval, greenish, reticulate, inserted beneath the epidermis of the leaf sheath or unfolding leaves, and hatch in about a week. The larvæ are pale yellowish green with a pale dorsal stripe and greatly resemble those of the alfalfa weevil. They feed chiefly on the tender leaf and flower buds beneath the sheath or at the bases of the flower heads where they destroy the florets. Maturity is reached in 17 to 20 days, pupation taking place in an oval net cocoon usually in the flowers. The adults emerge in a week, hibernate, and appear as soon as the new plants start in the spring. There is a single generation. The weevil attacks red and white clovers and is a European species now well distributed throughout North America. It is becoming quite common in the Northwestern States of Montana, Oregon, Washington, and in British Columbia. The fungus, *Entomophthora sphærosperma* Fres. (*Empusa*), kills the pupæ.

The alfalfa weevil, *Phytonomus posticus* (Gyllenhal)[4] (*Hypera variabilis* Hbst.) (Fig. 407), is the most destructive pest of alfalfa and clover in the Western States. The adults are 3–5 mm. x 1–2.4 mm., pale to dark brown or

[1] *Proc. Ent. Soc. Wash.*, 17, p. 155, 1915.
[2] L. P. Rockwood, *Can. Ent.*, 52, p. 39, 1920.
[3] F. M. Webster, Bul. 85, pt. 1, Bur. Ent. U. S. Dept. Agr. 1909.
L. P. Rockwood, "*Hypera nigrirostris* Fab. in the Pacific Northwest." *Can. Ent.*, 52, p. 38, 1920.
[4] E. G. Titus, Bul. 110, Utah Agr. Exp. Sta. 1910. *Ann. Ent. Soc. Am.*, 4, p. 452, 1911. *Circ.* 10, Utah Agr. Exp. Sta. 1913.
A. J. Cook, "An Alarming Menace." *Mthly. Bul.*, Cal. Hort. Com., 1, p. 19, 1911.
F. M. Webster, Bul. 112, Bur. Ent. U. S. Dept. Agr. 1912. (Complete.)
T. H. Parks, *Extens. Bul.* 7, Idaho Agr. Exp. Sta. 1913. *Jour. Econ. Ent.*, 7, p. 418, 1914.
G. I. Reeves, P. B. Mills, T. R. Chamberlin, S. J. Snow, and L. J. Bower. *Farmers' Bul.* 741, U. S. Dept. Agr. 1916.
H. R. Hagan, *Circ.* 31, Utah Agr. Exp. Sta. 1918.

black, the antennæ and legs paler, usually with a conspicuous dark longitudinal stripe on the dorsum which converges to a point before reaching the apex of the elytra, and with darker spots on the elytra. The dispersing summer flight occurs late in the season after which the adults hibernate in the fields under grasses or rubbish or in the crowns of the alfalfa plants. They emerge in the spring and begin the spring flight in search of food. The two flights very greatly increase the spread and distribution and may cover 20 to 60 or more miles in a year. The small oval, shiny yellow eggs are inserted into the stems or laid on the buds and leaves in the spring. The females may place as many as 40 eggs in a single puncture and each may lay from 600 to 800 eggs. Serious damage is often due to the many egg punctures in the stems of the alfalfa. Egg laying is completed in a few days in warm weather and the eggs hatch in about ten days. The young larvæ are green with black heads and a pale dorsal stripe. They have no true legs and live in a slightly curled position. When mature they are approximately 8 mm. long. The young larvæ usually feed in the developing leaf buds, eating the tips and stopping growth, but as they develop they gradually feed on the leaves, often completely stripping the plants. They become full grown in 50–60 days, drop to the ground, and among the leaves spin a frail oval lace-like cocoon in which pupation occurs and from which the adults emerge in 10–14 days. There is but one generation annually. The weevil is of European origin and first appeared near Salt Lake, Utah, in the spring of 1904. From this point it quickly spread into southern Idaho, southwestern Wyoming, and western Colorado. It appeared in Oregon and Nevada in 1920 and in Sierra County on the eastern side of the Sierras in California in 1923. It has since spread to adjacent counties in California. The western spread has probably been by automobile traffic. Further introduction into many of the other Western States is being guarded by quarantine inspection on all highways leading into the States from infested areas and by a complete quarantine on certain commodities likely to carry the weevil. Alfalfa appears to be the preferred host, but beans, clover, melilotus, fenugreek, locoweeds, black locust, peas, vetch, and other legumes are attacked. The use of native and introduced natural enemies is proving effective in many localities. The fungus, *Beauveria globulifera* (Speg.) (*Sporotrichum*), kills many of the larvæ, pupæ, and adults in the spring.

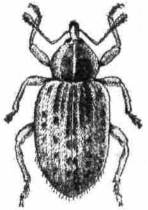

FIG. 407.—The alfalfa weevil, *Phytonomus posticus* (Gyllenhal). (After Webster, U. S. Dept. Agr.)

Among the methods of artificial control in alfalfa fields are:

(1) disking to hasten development of the first crop which is most damaged,
(2) harvesting the first crop as early as possible,
(3) dragging with brush or wire drag after cutting and while the fields are dry, to destroy the larvæ and pupæ by crushing or by the creation of a fine dust mulch,
(4) irrigating to hasten development of the next crop,
(5) spraying after cutting in the early spring or after cutting the first crop, with one pound of Paris green or two pounds of dry powdered arsenate of lead to 100 gallons of water,
(6) rotating to other crops every four or five years.

The dock weevil, *Phytonomus quadricollis* Lec., is 4 mm. long, dark brown or black, clothed with small rounded, dull yellow or gray scales, and with red legs. It feeds on dock in Colorado. **The knotweed leaf weevil,** *Phytonomus comptus* Say, is 3.3–5 mm. in length, elongate, flattened, rich brown to reddish black, with the legs and antennæ reddish. The larvæ and adults feed on the leaves of knotweed. The former pupate in cocoons on the upper sides of the leaves which are rolled for protection and concealment. The species occurs in the east, and in Colorado, Oregon, and Washington in the west. *Hyperodes hyperodes* (Dietz) (*Macrops*)[1] is 4.5–6 mm. long, rather slender, black, covered with grayish brown and dark brown scales intermixed with short hairs. In June, 1923, F. H. Wymore found the adults doing considerable damage by boring into the stems of young tomato plants and onions near Stockton, California.

Members of the large genus *Pissodes*[2] are rather small, reddish brown or black, sometimes spotted, weevils with widely separated rounded eyes, slender cylindrical beak as long or longer than the thorax, and longer, smoother, and more slender in the female than in the male, the elytra striate, punctured, and wider at the base than the prothorax. The males have eight and the females seven visible abdominal segments. The larvæ are wood borers; those of some species pupate in a cell lined with masticated excelsior-like bits of wood, and are called "chip-cocoons." Many are serious pests to forest trees. **Barber's fir weevil,** *Pissodes barberi* Hopkins, is 5–5.5 mm. long and clothed with white or yellowish brown scales. The larvæ breed in Sitka or tideland spruce in Northern California, Oregon, and Washington. **Burke's weevil,** *P. burkei* Hopk., is 6–7.7 mm. long, grayish, with a large distinct white spot on the posterior dorsum of each elytron. The larvæ mine the thick bark of normal and dying alpine or balsam fir in New Mexico, Arizona, Colorado, and Utah. **The California pine weevil,** *P. californicus* Hopk., is 5–7 mm. long, and causes deep scars in the thick bark of normal yellow pine in the high Sierras of California including the Yosemite Valley. **The ribbed pine weevil,** *P. costatus* Mann., is 5.5–7 mm. in length, dark brown to black, often abundant in the thick bark of dying and felled Sitka and other spruce trees and stumps in Colorado, California, Oregon, Washington, British Columbia, and Alaska. The **Engelmann spruce weevil,** *P. engelmanni* Hopk., is 5–5.3 mm. long, light to dark brown, and is often injurious to the tops and terminals of young trees of Engelmann spruce in the high mountains of Mexico, New Mexico, Arizona, Colorado, Wyoming, Utah, Montana, Idaho, and British Columbia. **The Douglas fir weevil,** *P. fasciatus* Lec., is 5–8.3 mm. long and reddish to brown or black. It mines the thick bark of normal, dying, dead, and felled trees and stumps of Douglas fir in Oregon, Washington, and British Columbia. **The lodgepole pine weevil,** *P. murrayanæ* Hopk., is 4–6 mm. long and very dark brown with a small posterior elytral spot. It mines the thin bark and the bases of small trees, above and below ground, of lodgepole pine in the mountains of Colorado, Utah, Wyoming, Montana, Idaho, and Eastern Washington and Oregon.

The Monterey pine weevil, *P. radiatæ* Hopk., is 5–7.4 mm. long, and is separated from all others by the acute posterior angles of the pronotum. It mines the stems, tops, and bases of young trees, above and below ground, and the thick bark of standing and felled trees and stumps of Monterey pine and other pines along the coast of California north into British Columbia. Ornamental pines in the Golden Gate Park, San Francisco, California, have also become infested by this pest. **The white pine weevil,** *P. strobi* Peck, is 4.5–6 mm. in length, dark to light brown with small white spots on the pronotum, and two nearly continuous white bands and white spots on the elytra. It is a very common and serious pest to the terminal shoots of white, pitch, and Labrador pines, and also infests red and Norway spruces east of the Rocky Mountains. It ranges west into the high mountains of New Mexico. **The Sitka spruce weevil,** *P. sitchensis* Hopk., is very similar to the preceding one and is very injurious to the tops and terminals of saplings and small trees of the Sitka spruce along the coast in Oregon, Washington, British Columbia, and Alaska. **The terminal pine weevil,** *P. terminalis* Hopping,[3] is 5.5–6.3 mm. long and yellow-brown in color. It attacks the terminals of large, perfectly healthy trees of lodgepole pine. The larvæ work in the pith and often kill the terminals to the first whorl. It is a serious pest and often devastates large areas in the

[1] W. G. Dietz, "Species of *Macrops* of N. A." *Trans. Am. Ent. Soc.*, 17, p. 28, 1889.

[2] A. D. Hopkins, "Contrib. towards a Mon. of Bark-weevils of the Genus *Pissodes*." Bul. 20, pt. 1, *Tech. Ser.* Bur. Ent. U. S. Dept. Agr. 1911.

[3] Ralph Hopping, *Can. Ent.*, 52, p. 133, 1920.

higher mountains of California. The larvæ are heavily parasitized. Adults hibernate in the larval galleries. **Webb's pine weevil,** *P. webbi* Hopk., is 4.8–6.8 mm. long and dark reddish brown to nearly black. It attacks the stems of young lodgepole pine above and below the ground, and the bark of normal and dying, standing and felled trees of lodgepole, yellow, and other pines in Mexico, Texas, New Mexico, and Arizona. **The Yosemite pine weevil,** *P. yosemite* Hopk., is 5–7 mm. long and reddish brown in color. It mines the thick bark of normal, injured, dying, dead, and felled trees and stumps, and also the bases and stems of young saplings of sugar, white, and yellow pines in the high mountains of California, Oregon, Washington, and British Columbia.

The avocado seed weevil, *Heilipus lauri* Boheman (*Hilipus*),[1] is 14–15 mm. in length, reddish, with a broken median and a continuous posterior white transverse band on the elytra. The larvæ breed in the seeds of the avocado and have been frequently taken in quarantine at California ports in shipments of avocados from Central America and Mexico where the weevil is common. Adults have also been taken from avocado nursery plantings in the State, but have never been found in the bearing orchards.

The lupine seed weevils, *Tychius lineellus* Lec., *T. prolixus* Casey, and *T. semisquamosus* Lec., are very small, oval, robust species 2–4 mm. long, black, clothed with gray and brown scales, which breed in the seed pods of lupines where the small white legless larvæ are often to be found feeding on the developing seeds. They all occur in California and the second one also in Nevada.

The bronze apple tree weevil, *Magdalis*[2] *ænescens* Lec.,[3] is 4–6 mm., long, metallic bronzy black, rather slender, with the elytra distinctly striate, and a long cylindrical snout. The adults emerge from hibernation in the spring and feed to some extent on deciduous native plants and fruit trees. The eggs are laid in punctures in injured, sunburned, or dead bark, and the larvæ mine under the bark and into the wood of injured, dying and dead trees, limbs, prunings, and stumps. They commonly breed in wounds or dead areas of healthy trees, and may be injurious to apple, cherry, hawthorn, and prune trees. Alder is an important native host. The weevil occurs in Montana, Washington, British Columbia, Alaska, Oregon, and California. The destruction of dead prunings and the careful painting or waxing of wounds largely eliminates infestations.

The black fruit tree weevil, *Magdalis gracilis* Lec. (Fig. 408), is 3–6 mm. long, dull or shining black, the dorsum coarsely punctured, and the elytra deeply striate. The adults appear in the early spring and eat small holes in the buds, flowers, leaves, and young fruit of almond, apple, apricot, peach, pear, plum, prune, and other fruit trees in California. The larvæ breed in dead wood and have been reared in great numbers by the writer from dead apricot, cherry, and prune which had been cut and piled for wood. The emerging adults almost completely defoliated trees in the vicinity of this woodpile. Willow, California Christmas berry, and other native rosaceous plants are the normal hosts. The range includes New Mexico, Nevada, and California. *Magdalis alutacea* Lec. is black, and alutaceous with a silver lustre. It feeds on Engelmann spruce in the high mountains of Colorado, New Mexico, California, Oregon, and the Northern States, and Canada. *M. cuneiformis* Horn has the head and prothorax black and the elytra dark blue. It feeds on the needles of yellow and other pines in the mountains of New Mexico, Colorado, Montana, California, and Washington. *M. gentilis* Lec. is 4 mm. long, bluish black, and feeds on Jeffrey and other pines in the Lake Tahoe region of Nevada and California. *M. lecontei* Horn is brilliant greenish violet or black and is common on the needles of yellow and sugar pines in July in the mountains of New Mexico, Arizona, Colorado, California, and Oregon. There are three distinct color varieties: *superba* Fall is green to blue-violet, and occurs in Arizona; *tenebrosa* Fall is entirely black, and is found in Colorado, New Mexico, and California; *tinctipennis* Fall is black with dark blue elytra inhabiting New Mexico and Arizona. *M. proxima* Fall is

[1] H. S. Barber, *Proc. Ent. Soc. Wash.*, 14, p. 181, 1912; 21, p. 54, 1919.
[2] H. C. Fall, Rev. of the Species of *Magdalis*," etc. *Trans. Am. Ent. Soc.*, 39, p. 23, 1913.
[3] G. F. Mozenette, *Jour. Econ. Ent.*, 12, p. 426, 1919.

3.6–4.5 mm. long, black, and occurs on Monterey and other pines in California and Oregon.

The nut and acorn weevils belonging to the genus *Balaninus* [1] are medium-sized, black, yellowish, or brown, somewhat slender or robust weevils, with long legs and conspicuously long, slender, curved or nearly straight beak which varies in length from nearly as long as to much longer than the body. They breed in the meat of nuts and acorns. The adults appear in July through September and drill holes with the beak through the husk and shell of the nuts. Several eggs may be inserted through a single hole in the shell into the meat by means of the ovipositor. The larvæ normally mature when the nuts begin to fall, and enter the ground where the winter is spent. Stragglers remain in the nuts all winter and enter the soil in the spring. Pupation does not occur until summer and the adults begin to appear in July. Serious damage is often occasioned by their attacks and from 20 to 75 per cent of the crop ruined.

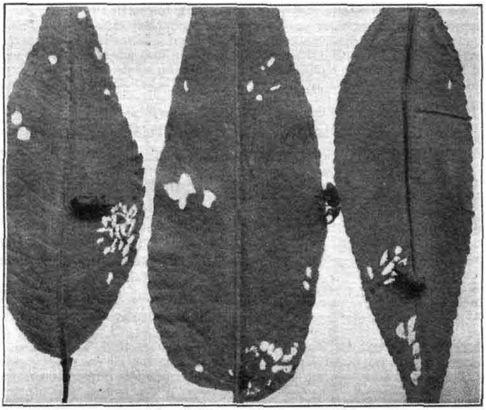

FIG. 408.—The black fruit tree weevil, *Magdalis gracilis* Lec., and work on almond leaves.

The hickory nut or pecan weevil, *Balaninus caryæ* Horn, is 7–9 mm. long, brownish, and sparsely clothed with yellowish and whitish hairs. The beak of the female is much longer than the body, that of the male shorter. The species is a serious pest to hickory nuts and pecans in the States east of the Rocky Mountains, and ranges west into the eastern part of Colorado. **The chestnut weevil,** *B. rectus* Say, is 8.5–9 mm. in length, brownish, clothed with pale brown scales, and with yellow or orange spots on the elytra. The beak of the female is longer than the body, straight with a slight curve near the tip, and shorter in the male and curved throughout. It breeds in chestnuts and acorns, preferring the biennial fruiting oaks. It is a common eastern species, ranging west into Arizona. **The mottled acorn weevil,** *B. nasicus* Say, is 5–7.5 mm. long, robust, dark chestnut brown, clothed with dark brown and yellow scales forming a broad stripe

[1] Geo. H. Horn, "Syn. of N. A. *Balaninus.*" *Proc. Am. Phil. Soc.*, 13, p. 458, 1873.
F. Blanchard, "Table of *Balaninus.*" *Bul. Brooklyn Ent. Soc.*, 7, p. 107, 1884.
T. L. Casey, *Ann. N. Y. Acad. Sci.*, 9, p. 655, 1897; "*Balanini,*" *Can. Ent.*, 42, p. 114, 1910.
F. H. Chittenden, "New Species of *Balaninus,*" etc. *Proc. Ent. Soc. Wash.*, 10, p. 19, 1908. "The Nut Weevils." *Circ.* 99, Bur. Ent. U. S. Dept. Agr. 1908.
F. E. Brooks, *Snout Beetles That Injure Nuts.* Bul. 128, W. Va. Agr. Exp. Sta. 1910.

on each side of the prothorax and transverse bands on the elytra. The beak is longer than the body in the female, shorter in the male, and evenly curved in both sexes. It breeds in acorns and is common in the east, ranging west into New Mexico and Arizona. **The grizzly acorn weevil,** *B. q-griseæ* Chittenden, is 6–7 mm. long, brownish; the rostrum, antennæ, and legs reddish; the dorsum yellowish brown, and hairy; the elytra with variable transverse gray bands. The beak of the female is 3/5 and of the male less than ½ the length of the body and curved. It breeds in the acorns of the griseous oak in Arizona. **The California acorn weevil,** *B. uniformis* Lec. (*B. occidentis* Casey), is 5.5–6.5 mm. long, clothed with yellowish brown scales, the elytra with darker spots. It breeds in the acorns of several species of oaks and occurs in New Mexico, Utah, California, Oregon, and Washington. It is the only species inhabiting the Pacific Coast region.

The pepper weevil or barrenillo, *Anthonomus*[1] *eugenii* Cano (*A. æneotinctus* Champion)[2] (Fig. 409), is 2.5–3.1 mm. in length, subovate, shining, pale, reddish brown to black with a brassy lustre, the antennæ and portions of the legs reddish, clothed with pale yellowish brown pubescence, the beak curved, and slightly longer than the head and thorax. In some forms there are whitish lines on the dorsum due to the arrangement of the pubescence. The very small, white, legless larvæ feed in, and discolor or completely destroy, the fruiting pods of bell or sweet and chili peppers and are a very serious pest, particularly to late plantings, injuring as high as 50% of the chili peppers. It is a Mexican species which has been introduced into Texas, New Mexico, and Southern California. The outbreak in California first occurred in 1923.

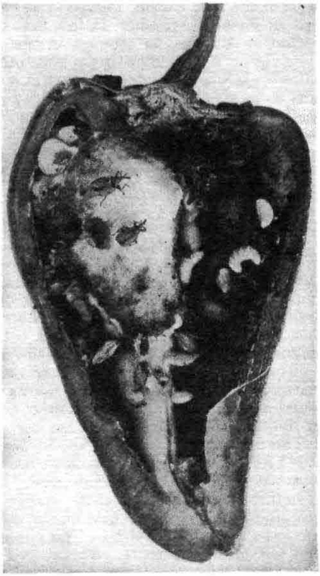

FIG. 409.—The pepper weevil, or barrenillo, *Anthonomus eugenii* Cano. Infested pepper showing larvæ, pupa, and adults.

The Arizona wild cotton or thurberia boll weevil, *Anthonomus grandis* Boh. var. *thurberiæ* Pierce,[3] is 5–5.5 mm. long, stout, reddish black, and

[1] Wm. G. Dietz, "Rev. of Genera and Species of *Anthonomini* of N. A." *Trans. Am. Ent. Soc.*, 18, p. 177, 1891.
[2] F. C. Pratt, Bul. 63, pt. 5, Bur. Ent. U. S. Dept. Agr., p. 55, 1907.
G. C. Champion, *Ent. News*, 18, p. 366, 1907.
[3] W. D. Pierce, "The Occurrence of a Cotton Boll Weevil in Arizona." *Jour. Agr. Research*, 1, p. 89, 1913. Orig. desc.
B. R. Coad, *Relation of Arizona Wild Cotton Weevil to Cotton Planting in Arid West.*

clothed with coarse, pale yellowish pubescence. According to Pierce it "differs from the cotton boll weevil on cotton by its greater robustness; the more golden appearance of the scales; the slighter constriction of the prothorax; its stouter and more coarsely sculptured beak; its slightly more compact antennæ, with funicle of a lighter color than the club; its stouter legs, with a distinct second tooth on the middle femora; the wings which shows a slightly more distinct spot." This interesting species breeds in the bolls of the wild cotton, *Thurberia thespesioides* A. Gray, in the mountains of southeastern Arizona. In fear that it may become a pest to cultivated cotton in Arizona, an attempt is being made to destroy all infestations near cotton plantings with the hope of confining the weevil to the mountains.[1] It was reported on cotton near Tucson in 1920,[2] but the outbreak was subsequently eradicated. It does, however, exist in certain cotton sections, and an attempt is being made to restrict its spread. *Anthonomus albopilosus* Dietz and *A. solani* Fall both feed on nightshade in California, Arizona, and New Mexico; the former also on croton. *A. hæmatopus* Boh. (*A. sycophanta* Walsh, *A. bolteri* Dietz) is 2.5–3 mm. long, black, the elytra and abdomen reddish, and the legs reddish or black. It breeds in galls made by sawflies on willow, and ranges from the east to Colorado, New Mexico, California, and Oregon.

The plum gouger, *Coccotorus scutellaris* Lec. (*Anthonomus prunicida* Walsh),[3] is 6 mm. long, black with gray pubescence; the head, antennæ, thorax, and legs, ochre, and the elytra mottled with ochre. The adults appear in the spring and oviposit in punctures in the skin of the young fruit of wild and cultivated American plums. The larvæ eat into the pit and kernel where pupation occurs. The adults emerge when the fruit matures and falls, and hibernate in the soil. The species occurs in the east and ranges west into Texas, Colorado and Montana. Jarring the trees in the early morning to capture the adults, or spraying with 2 pounds of powdered arsenate of lead to 50 gallons of water after the petals fall, and again in 10 days, afford control.

The currant fruit weevil, *Pseudanthonomus validus* Dietz,[4] is very small, 2.2–2.7 mm. in length, pale reddish brown and thinly clothed and marked with pale yellow or white pubescence. The adults appear in the spring and puncture the young fruit of the currant near the stems in which the eggs are inserted. The larvæ feed on the developing seeds. The fruits dry up around the stems and drop. The pupal stage is passed in the fallen fruit and the adults hibernate. This weevil occurs in Canada and the middle west ranging into Montana, Colorado, and New Mexico.

The small black weevils belonging to the genus *Orchestes* are chiefly leaf miners on willows in the larval stages and the adults eat small holes in the leaves (Fig. 410). In most species the antennæ and legs are reddish. The length varies from 2–4 mm. *O. salicis* Linn. is a European species common in many parts of North America and re-

Bul. 233, U. S. Dept. Agr. 1915. "Biology of the Arizona Wild Cotton Weevil." Bul. 344, *Prof. Paper*, U. S. Dept. Agr. 1916.

[1] A. W. Morrill, *Jour. Econ. Ent.*, 10, p. 312, 1917.

[2] A. W. Morrill, *Cal. Cultivator*, 56, pp. 5, 9, Jan. 1, 1921.

[3] C. P. Gillette, Bul. 71, Colo. Agr. Exp. Sta., p. 14, 1902.
R. A. Cooley, Bul. 62, *Third Ann. Rept. State Ent.*, Mont. Agr. Exp. Sta. 1905.
F. H. Chittenden, *Proc. Ent. Soc. Wash.*, 27, p. 131, 1925.

[4] R. A. Cooley, Bul. 102, Mont. Agr. Exp. Sta. 1914; *Jour. Econ. Ent.*, 7, p. 193, 1914.

corded in California in the west. *O. canus* Horn ranges west into Colorado. *O. parvicollis* Lec. (Fig. 410) is common in Colorado, Nevada, and California. *O. puberulus* Boh. occurs in California. *O. rufipes* Lec. is the most widely distributed western species, occurring in New Mexico, Colorado, Utah, California, and ranging north into Alaska. *It is an alpine and boreal species.*

The desert arrowweed weevil, *Dinocleus molitor* (Lec.) (*Centrocleonus*), is a large black weevil 15–17 mm. long, the legs and apical portions of the elytra, and often much of the body, clothed with white scales; the prothorax deeply and coarsely punctate; elytra punctures in rows; the rostrum large and short. It is common on arrow-weed in the desert areas of Mexico, Arizona, and Southern California.

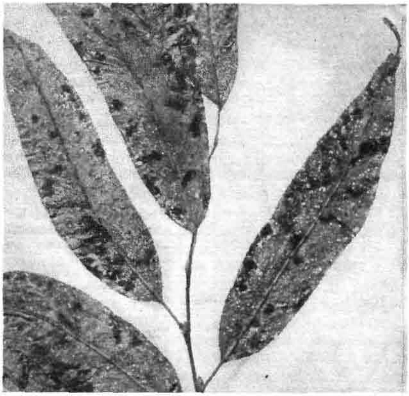

FIG. 410.—Feeding punctures of the willow leaf weevil, *Orchestes parvicollis* Lec., on willow. (Photo furnished by W. W. Jones.)

The radish weevil, *Cleonus sparsus* Lec.,[1] is 6.5 mm. in length, black, clothed with yellowish gray pubescence, and often appears bluish gray or black with four bluish gray stripes on the elytra. The adults appear in the spring and lay the small smooth, oval, dirty yellowish eggs directly on the roots of the radishes, turnips, and other food plants in June and July. The eggs are often obscured by dirt adhering to the sticky substances over them. The larvæ are white with brown head, sparsely covered with fine brown hairs, legless, and 9 mm. long. They tunnel throughout the pulp, often completely destroying young plants. Pupation occurs in a cell in a longitudinal groove on the outside of the root. The species is recorded as a pest only in Oregon. It was however, originally described from Colorado, so it probably occurs throughout the west. It was recently discovered at Campbell, Calif., by R. D. Hartman in May, 1924. *C. canescens* Lec.,[2]

[1] A. L. Lovett, *Second Bien. Crop Pest and Hort. Surv.* 1913–1914. Ore. Agr. Exp. Sta., p. 154, 1915.

[2] C. P. Gillette, *Jour. Econ. Ent.*, 5, p. 367, 1912.

is 10 mm. long, black and clothed with white pubescence. The adults appear in the spring and are destructive to the buds, leaves, and newly set fruit of apple, apricot, and peach trees, chiefly those on new soil in Colorado and Utah. *C. quadrilineatus* (Chev.) occurs in Texas, New Mexico, Arizona, and Colorado. The larvæ attack the roots of locoweed and lupines. *C. trivittatus* (Say) also attacks locoweed in Colorado and New Mexico.

The knotweed weevil, *Lixus parcus* Lec. (Fig. 411), is 5.5–8 mm. long, slender, and black. It is clothed with reddish scales upon emerging, but these soon rub off leaving a thin white pubescence. The beak is stout and as long as the prothorax. The yellowish white larvæ develop in elongated stem galls 8–12 mm. long and 3–4 mm. wide on the main branches of the common knotweed near the bases of the plants. Many galls may occur on a single plant. Pupation occurs in late summer and adults issue in the fall of the year. The pupæ are heavily parasitized by undetermined parasites. The species is very common in Central California. C. V. Riley reports it from galls of Juneberries in California.[1] *Lixus musculus* Say is a like species producing similar galls on the stems of knotweed in the Eastern States, and in Texas and Colorado. *Lixus fimbriolatus* Boh. (*L. macer* Lec.) is 12–14 mm. long, very slender, and shining black with fine white pubescence. The larvæ live in the stems of the sawtooth sunflower and the ample-leaved goosefoot in the middle west. It ranges into Texas, Colorado, and Utah. **The wormwood weevil,** *Lixus perforatus* Lec., is 8–12 mm. in length, quite slender, black, thinly clothed with gray pubescence, the beak as long as the prothorax finely punctured, while the head is coarsely punctured. The adults appear in April and May and insert the small, oval, orange-yellow eggs into the stems of the wormwood. The yellowish white larvæ feed in the stems where pupation also occurs. The adults hibernate in the dead stalks. The weevil is quite common throughout California. A closely related species lays its eggs in the stems of lupine in which the larvæ breed, according to the findings of W. W. Jones who collected eggs at Berkeley, California, in April, 1924. *Lixus asper* Lec. is 11.3 mm. long, dull black with gray pubescence, and breeds on dock in middle and Southern California. **The smartweed weevil,** *Lixus mucidus* Lec., has recently been taken in large numbers on smartweed in the Sacramento Delta, California, by F. H. Wymore. The adults are 13–18 mm. long, covered with yellowish brown scales, and are gray when rubbed. This beetle occurs in the middle west.

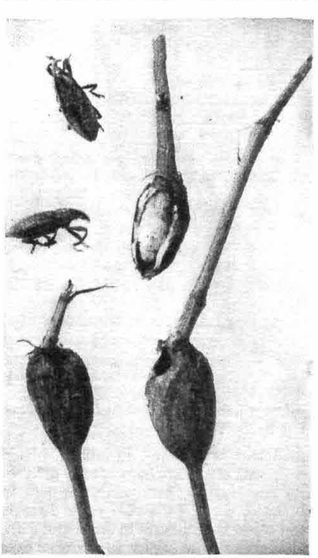

FIG. 411.—The knotweed weevil, *Lixus parcus* Leconte. Adults, pupa, and galls on stems of knotweed.

The potato stalk borer, *Trichobaris trinotata* (Say) (Figs. 412, 413, 414), is 3–4 mm. long, black, densely clothed with fine prostrate gray or white

[1] F. M. Webster, "Food Plants of the *Lixi*." *Proc. Ent. Soc. Wash.*, 2, p. 339, 1892.

hairs, causing a dull bluish gray or frosted appearance. The front of the prothorax is orange-yellow. There are three small black spots at the base of the elytra. The adults hibernate in the dead stalks of the host plants and appear in the spring of the year. The females puncture the growing stalks and insert in each hole a single oval, pearly white egg. The larvæ work in the centre of the stalks, and are yellowish, legless grubs with brown heads, slightly curved, and 10–13 mm. long when mature. They pupate in a rough, oval, greenish cocoon 13 mm. long, made from the frass and chewed bits of the stalks which are cemented together within the burrows. The adults remain in the old stalks during the winter. There is but a single brood. The species is a common eastern pest to potatoes, but also attacks ground cherry, eggplant, bull nettle, horse nettle, Jimpson weed, purple thorn apple, tobacco, and cocklebur. It ranges west into New Mexico, Arizona, and California. Efficient control is obtained by raking up and burning the dead vines in which the adults hibernate after harvest.

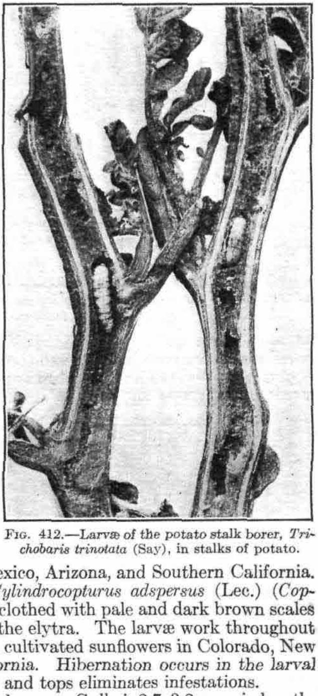

FIG. 412.—Larvæ of the potato stalk borer, *Trichobaris trinotata* (Say), in stalks of potato.

The Jimpson weed borer, *Trichobaris mucorea* (Lec.), is almost identical in coloration but a little larger than the preceding species for which it has generally been mistaken in the west. It is common in the arid regions of Mexico, Arizona, and Southern California, and normally breeds in Jimpson weed but also attacks potatoes, tomatoes, eggplants, and nightshade. *T. compacta* Casey also breeds in Jimpson weed in New Mexico, Arizona, and Southern California.

The sunflower snout beetle, *Cylindrocopturus adspersus* (Lec.) (*Copturus*), measures 4.1 mm., is black, clothed with pale and dark brown scales and with white tranverse spots on the elytra. The larvæ work throughout the length of the stalks of wild and cultivated sunflowers in Colorado, New Mexico, Utah, Arizona, and California. Hibernation occurs in the larval stage in the stalks. Burning roots and tops eliminates infestations.

The cabbage curculio, *Ceutorhynchus rapæ* Gyll., is 2.7–3.2 mm., in length, robust, oblong-oval, black clothed above with yellowish or grayish scales and beneath with whitish scales, the beak cylindrical and slightly longer than the head and prothorax. The hibernating adults appear in April and May and insert the small, gray oval eggs in the stems of the host plants.

They hatch in about a week and feed within the stems and on the edges of the leaves, chiefly of seeding plants of cabbage, cauliflower, hedge mustard, horseradish, mustard, peppergrass, radish, shepherd's purse, and turnip,

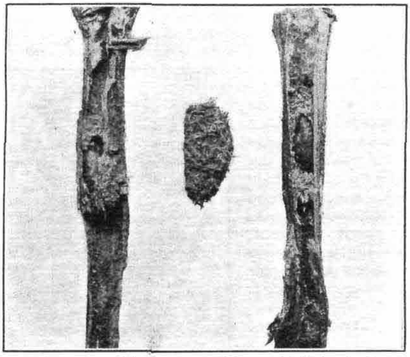

FIG. 413.—Pupæ and cocoons of the potato stalk borer, *Trichobaris trinotata* (Say), in dried potato stalks.

but may prove quite injurious to cultivated crops. Pupation occurs in round earthen cocoons just beneath the surface of the ground. A life cycle requires 6 to 7 weeks and there are several broods. The beetle was introduced from Europe and ranges west into Colorado, New Mexico, and

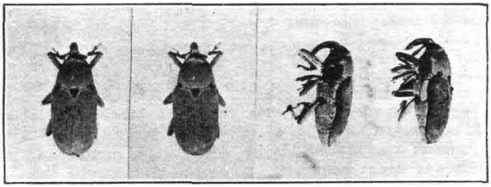

FIG. 414.—The potato stalk borer, *Trichobaris trinotata* (Say). Adults.

California. The use of trap crops and arsenical sprays is an effective means of control.

The plum curculio, *Conotrachelus nenuphar* (Hbst.),[1] is 4.5–6.5 mm. long, robust, oval, rough, brown, black and gray in color, the beak stout, curved, and slightly longer than the head and prothorax. The adults hibernate under rubbish and in secluded places, and appearing in the spring.

[1] A. L. Quaintance and E. L. Jenne, *The Plum Curcilio.* Bul. 103, Bur. Ent. U. S. Dept. Agr. 1912. (Complete.)

They make feeding and crescent-shaped egg punctures in the fruit as soon as set. Each female may lay from 100 to 300 eggs, and in puncturing the fruit fungous diseases are often introduced which cause great losses in addition to the injury due to the curculio. The eggs are oval, reticulate, and pale green, and are inserted just beneath the epidermis of the fruit. They hatch in a week and the small whitish legless grubs feed on the pulp, maturing in 12 to 18 days. Infested fruit drops prematurely. Pupation occurs in a small earthen cell in the soil and requires 3 to 4 weeks. The entire life cycle usually covers from 5 to 7 week. The adults which emerge, hibernate, there being but a single brood annually. The species normally breeds on wild hawthorn and plums, but has become a very serious orchard pest attacking apples, apricots, cherries, currants, grapes, huckleberries, peaches, pears, persimmons, plums, and quince. It is confined to the regions east of the Rocky Mountains and is recorded in the eastern part of Colorado and the Bitter Root Valley in Montana.[1] It is controlled by thorough spraying with 3 pounds of powdered arsenate of lead to 100 gallons of water applied as the leaf buds are opening, and again before and after the blossoming period for the apple, and after the blossom petals fall for the cherry, plum, and peach.

The strawberry crown weevil, *Tyloderma fragariæ* Riley, is 3.5–4.2 mm. long, oblong-oval, blackish, the legs and elytra reddish brown, the latter with transverse blackish areas on the dorsum. The yellowish white grubs breed in the crowns and roots of strawberries. The weevil ranges west into Colorado.[2]

The cactus weevils,[3] *Gerstæckeria calthrata* Lec. (*Acalles*), *G. basalis* (Lec.) and *G. porosa* (Lec.), are robust, black, clothed with brown or dull hair and 4.7, 5, and 8 mm. long, respectively. The larvæ breed in the joints of opuntia cactus. The first occurs in Texas, New Mexico, Arizona, and Colorado; the second, in Colorado, Wyoming, and Nebraska; the third, in Kansas, Colorado, and Arizona. There are many other species which also breed in cactus.

Members of the genus *Cossonus*[4] are black or dark, elongated, flattened, medium-sized weevils which usually live under the bark or in the heartwood of limbs and trunks of trees and shrubs. *C. lupini* Van Dyke is 5 mm. x 1.25 mm. and breeds in the dead branches of bush and tree lupines growing on the sand hills along the ocean, in middle California. *Rhyncolus pallens* Casey is often associated with the species. *Cossonus hubbardi* Schwarz is 3.7–4.8 mm. long and breeds in the dead portions of the giant cereus cactus in Arizona. *C. pacificus* Van Dyke is 7 mm. in length and occurs under the bark of dead aspen in the Sierras of Lake Tahoe, California, and Nevada. *C. quadricollis* Van Dyke is 6.25 mm. long and has been taken under dead bark of cottonwood in California and Oregon. *C. subareatus* Boh. is 4.5–7 mm. long and occurs under the bark of maple, aspen, and poplars in the high mountains of New Mexico, California, Nevada, Washington, and Montana. *C. crenatus* Horn is 3.5–5.5 mm. long with legs black or reddish. It is found beneath the dead bark of Jeffrey, lodgepole, digger, and yellow pines in Mexico, New Mexico, Arizona, California, and Oregon. *C. piniphilus* Boh. is 4–6 mm. in length with a wedge-shaped prothorax. It occurs beneath the bark of Bishop, lodgepole, and Monterey pines along the coasts of California, Oregon, and Washington. *C. ponderosæ* Van Dyke is 6.5 mm. long and is found under the bark and in the sapwood and heartwood of dead Jeffrey, sugar, and yellow pines in the high mountains of California and Nevada.

[1] R. A. Cooley, Bul. 150, Mont. Agr. Exp. Sta., p. 26, 1922.

[2] C. P. Gillette, Bul. 71, Colo. Agr. Exp. Sta., p. 19, 1902.

[3] W. D. Pierce, "The Cactus Weevils." *Proc. U. S. Nat. Mus.*, 42, p. 159, 1912.

[4] E. C. Van Dyke, "The Species of *Cossonus* of America North of Mexico." *Bul. Brooklyn Ent. Soc.*, 10, p. 1, 1915. "Notes and Descriptions." *Bul. Brooklyn Ent. Soc.*, 11, p. 71, 1916.

CALANDRINÆ (Subfamily). Billbugs. **The yucca weevil,** *Scyphophorus yuccæ* Horn, is 15–17 mm. in length, black, the elytra deeply striate and shorter than the abdomen. The adults feed on the sap of living yucca in the arid regions of Southern California while the larvæ breed in the bases of the green flower stalks and hearts of the same plants. *S. acupunctatus* Gyll. is 10–19 mm. long, black, and much like the above. It breeds in agave or century plant and ranges from Central America into Texas, New Mexico, Colorado, Arizona, and California. F. E. Blaisdell[1] has observed the adults feeding on the sap of grapevines in Southern California.

The curlew bug, *Sphenophorus cariosus* (Olivier) (*Calandra callosus* Lec., Horn), measures 8–11 mm., is black, elongate-oval, the beak three-fourths as long as the prothorax. The larvæ breed in the stalks at the base or on the roots of corn, rice, and grasses; the adults cut slits at the bases of the young corn plants, and are often quite destructive to the crop in New Mexico and Arizona. The adults hibernate in the stubble which should be uprooted and burned after harvest as a control measure. The weevil is common in the Eastern and Southern States.

The tule billbug, *Sphenophorus discolor* Mann. (*S. pictus* Lec.) (Fig. 415), is 15–18 mm. in length, elongate, black and white, usually black above and white beneath. The

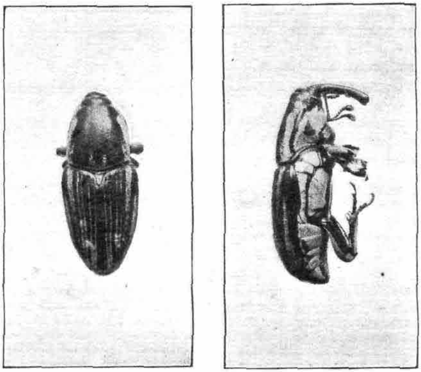

FIG. 415.—The tule billbug, *Sphenophorus discolor* Mann. form *pictus* Lec.

form *pictus* Lec. has longitudinal white dorsal markings. This large beetle normally breeds in tules and cat-tails along the rivers, and the adults frequently injure barley, oats, and wheat in the vicinity of the breeding places by cutting through the stalks and thus killing the heads. The species occurs throughout California. *S. pertinax* (Oliv.) normally breeds in cat-tail but also seriously attacks corn planted on new land where the native host previously grew. It is an eastern species which ranges west into Arizona, Utah, Nevada, and Southern California. **The grass billbug,** *Sphenophorus graminis* Chittenden, is a black weevil 7–9 mm. long, the larvæ of which feed on and often seriously injure the roots of native grasses in Wyoming, Utah, and Oregon. *S. phœniciensis* Chitt. is 7–8 mm. long, the head and rostrum shining black, the remainder of the body variable reddish, gray, and black. It is often a severe pest to sugar cane and wheat in the Salt River Valley, Arizona.[2] It also ranges into California.

[1] *Insect Life*, 5, p. 35, 1892.

[2] A. W. Morrill, *Seventh Ann. Rept. Ariz. Com. Agr. and Hort.*, p. 39, 1915.

The granary weevil, *Stiophilus* [1] *granarius* (Linn.) (*Calandra granaria* Linn.), is 3–4 mm. long, slender, moderately shining pale to dark chestnut brown; the beak two-thirds as long as the prothorax; the pronotal punctures coarse and elongated; the elytra striate and punctate; wingless. The adults are to be found wherever grain and cereal products are stored for any length of time. They eat small holes in the grain into which the tiny elliptical white eggs are inserted. The larvæ are white, legless, rather robust grubs which work within the kernels and are often in sufficient numbers to completely destroy great quantities of dried cereals. Pupation occurs within a fragile pupal case made by gluing small fragments together within the kernels. In small grains like wheat and barley, a single larva inhabits a kernel, while in corn and other large grains many larvæ may occur in a kernel. The species is very prolific and produces large, quickly developing broods throughout the year, and continues to breed as long as any food remains. The length of the life cycle depends upon the temperature and varies from four weeks in summer to several months in winter. As many as six broods are produced annually in the southern portions of our region. Warm damp conditions favor, while dry, hot conditions retard development. Practically all kinds of stored cereals such as barley, chick peas, corn, rice, sorghum, oats, wheat, and cereal products are subject to attack. It is a cosmopolitan species which is a destructive pest throughout the world and is to be expected in granaries, flour and grain mills, bakeries, warehouses, feed stables, stores, and hotels. To prevent infestation, cereals should be thoroughly dried and stored in dry, well ventilated, tight bins or elevators. The weevils can be killed in infested grain by heating for 6 hours at 120–130° F., or by fumigating with 4 to 6 pounds of carbon disulfid per 1,000 cubic feet of space, or with hydrocyanic acid gas. W. W. Mackie has found that the treatment of seed wheat for bunt, with copper carbonate dust applied at the rate of 2 ounces per bushel, kills all of the weevils and prevents reinfestation.

The rice weevil, *Sitophilus oryza* (Linn.) (*Calandra oryzæ* L.),[2] is about the same size and shape as the preceding species, the color is dark reddish brown with four paler reddish spots on the elytra, and the punctures on the pronotum are circular and much more pronounced on the elytra. The habits, distribution, and control are much the same as for the granary weevil. For control, see the preceding species.

PLATYPODIDÆ. Wide-headed Ambrosia Beetles.

Wilson's wide-headed ambrosia beetle, *Platypus wilsoni* Swaine,[3] is 5.5 mm. in length very slender, shining, densely granulate and punctate, brown clothed with long yellow hairs. The females extend their minute galleries through the bark and into the heartwood for 6 to 14 inches and prefer unhealthy, dying, or recently felled timber. Perfectly healthy trees are also attacked. The many eggs are scattered along the galleries in groups of 10 or 12. The small larvæ feed on ambrosia fungi provided in the burrows by the parents and reach maturity in 5 or 6 weeks. The pupal cells are cut parallel with the grain of the wood in groups along the deeper galleries. This beetle is often quite destructive and attacks all conifers excepting the cedars, cypresses, and closely related trees. Firs, hemlocks, and Douglas fir are commonly infested. The species

[1] R. T. Cotton, *Jour. Agr. Research*, 20, p. 409, 1920.
[2] R. T. Cotton, "The Rice Weevil." *Jour. Agr. Research*, 20, p. 409, 1920.
[3] J. M. Swaine, *Can. Ent.*, 48, p. 97, 1916. Orig. desc.
W. J. Chamberlin, Bul. 147, Ore. Agr. Exp. Sta., p. 35, 1918.

occurs along the Pacific Coast in the mountains of California, Oregon, Washington, and British Columbia. The removal of infested trees and cutting unhealthy timber first, assists in the control.

SCOLYTIDÆ (*Ipidæ*).[1] Barkbeetles, Scolytid Beetles.

These are small robust or slender beetles, cylindrical, usually brown or black, the head partially concealed from above, and the antennæ clubbed. They are very destructive wood borers which are the most serious forest pests and some of which also attack fruit, shade, and ornamental trees and shrubs. Control measures are summarized as follows:

1. Burn all windfalls, snow breaks, and freshly cut slash before the first of May.
2. Cut and mill infested areas first. Leave no logs in the woods over a year. Tops, bark, and slabs of infested timber should be burned immediately.
3. Inaccessible infested trees should be cut and barked, and the limbs, tops, and bark burned. Small trees should be entirely burned.

The beetles are extensively preyed upon by birds, chiefly woodpeckers, and by mites, predaceous, checkered, colydid, and other beetles, robberflies, hymenopterous parasites, and parasitic bacteria and fungi.

The shot hole borer or fruit tree barkbeetle, *Scolytus rugulosus* Ratzeburg (*Eccoptogaster*) (Figs. 416–418), is 2–3 mm. long, nearly black, the antennæ, legs, and tips of the elytra cinnamon red. The adults appear in April, May, and June, and after mating the females bore small round holes 1.3 mm. in diameter through the bark of healthy, injured, dying or dead wood. They mine large straight primary galleries in which, at various short intervals along the sides, they make small pockets into which the eggs are deposited. The small whitish grubs excavate secondary galleries at right angles to the primary. These galleries are first very narrow, but becone gradually larger as the larvæ grow and extend them, until when maturity is reached, rounded cells are formed at the ends where pupation takes place. Mature larvæ are white or yellowish brown, 3 mm. long, legless, and slightly curved. The winter is passed in the larval and pupal stages, and in the southern range in the adult stage also, in the cambium layer beneath the bark. There are two or three broods annually; the life cycle of the summer broods requires about 23 days. The species prefers injured, sickly, or dying trees, and rarely attacks perfectly normal ones. The attack may start in a

[1] A. D. Hopkins, "List of Generic Names and their Type Species of *Scolytoidea*." *Proc. U. S. Nat. Mus.*, 48, p. 115, 1915. "The Genus *Dendroctonus*." *Tech. Ser.* 17, pt. 1, Bur. Ent. U. S. Dept. Agr. 1909. "Preliminary Classification of the Superfamily *Scolytoidea*." *Tech. Ser.* 17, pt. 2, Bur. Ent. U. S. Dept. Agr. 1915. "Classification of the *Cryphalinæ*," etc. *Rept.* 99, U. S. Dept. Agr. 1915.

J. H. Miller, "Cone Beetles. Injury to Sugar Pine and Western Yellow Pine." Bul. 243, *Prof. Paper*, U. S. Dept. Agr. 1915.

F. E. Brooks, "Orchard Barkbeetles and Pinhole Borers, and How to Control Them." *Farmers' Bul.* 763, U. S. Dept. Agr. 1916.

J. M. Swaine, "Canadian Barkbeetles." Bul. 14, *Ent. Branch, Dom. Canada Dept. Agr.*, pt. 1, 1917; pt. 2, 1918.

W. J. Chamberlin, *Bark-Beetles Infesting Douglas Fir*. Bul. 147, Ore. Agr. Exp. Sta., 1918.

R. Hopping, "Control of Bark-Beetle Outbreaks in British Columbia." *Circ.* 15, *Ent. Branch, Dom. Can. Dept. Agr.*, 1921.

M. W. Blackman, "Mississippi Bark Beetles." *Tech. Bul.*, 11, Miss. Agr. Exp. Sta. 1922.

sunburned or injured area and spread to healthy portions, or in cases of abundance, healthy trees are subject to their depredations. The adults frequently make short burrows into the buds of healthy fruit trees during the late winter and spring in California. It is frequently an orchard pest and is known to attack almond, apple, apricot, loquat, mountain ash, cherry, choke cherry, elm, hawthorn, Juneberry, nectarine, peach,

FIG. 416.—The shot hole borer, *Scolytus rugulosus* Ratz. Adults and exit holes in bark of apricot tree.

pear, plum, prune, and quince. From Europe, this beetle has been introduced into many parts of North America and is known in Colorado, New Mexico, California, and Oregon, and probably has a much wider western distribution. The dressing of tree wounds, burning of prunings, and proper care of the orchards eliminate and prevent attacks. **The California white pine scolytid,** *Scolytus præceps* Lec., excavates two nearly straight transverse galleries from a central entrance burrow and basal cavity in the living bark and surface of the wood of white and other firs in Califor-

nia, Utah, Idaho, and New Mexico. **The fir tree destroyer,** *Scolytus subscaber* Lec. (*Eccoptogaster*), is a destructive enemy of alpine fir, grand fir, and white fir, and occurs in California, Oregon, Washington, Idaho, and British Columbia. The adults make short tranverse galleries one to three inches long, and the larvæ excavate two long, nearly straight transverse galleries (Fig. 419) from the central entrance burrow and central or side

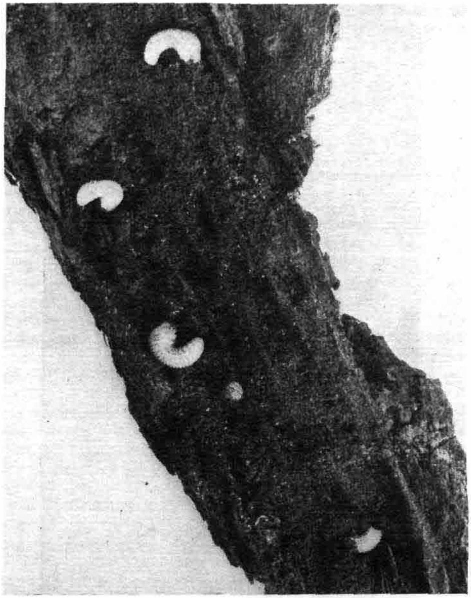

FIG. 417.—Larvæ of the shot hole borer, *Scolytus rugulosus* Ratz., and work beneath the bark of prune tree.

cavity in the bark of living, injured, and declining trees. They frequently kill alpine fir in California and grand fir in Idaho. *S. monticolæ* (Swaine) (*Eccoptogaster*) breeds in western white pine and Douglas fir in British Columbia. *S. tsugæ* (Swaine) mines mountain hemlock and Douglas fir in British Columbia. **The one-spined scolytid,** *S. unispinosus* Lec., is 2.3–2.7 mm. long and shining black. The larvæ excavate two short straight longitudinal galleries from an entrance burrow in the bark of normal, injured, dying or recently felled Douglas fir, western larch, and

Engelmann spruce. The species is widely distributed under the bark on saplings and limbs of old trees and may kill saplings, but is not regarded as a serious pest. It is common throughout the western region and north into British Columbia.

The Sitka spruce dolurgus, *Dolurgus pumilus* (Mann.), is 1.6–2 mm. long, and excavates irregular galleries in bark of dying, dead, and felled Sitka spruce. Its galleries often originate from those of *Ips concinnus* (Mann.).

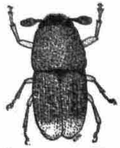

FIG. 418.—The shot hole borer, *Scolytus rugulosus* Ratz. Adult.

The round-headed or Colorado pine beetle, *Dendroctonus convexifrons* Hopkins (*D. approximatus* Dietz), is 5–6 mm. in length, shining reddish brown, the elytral declivity with long hairs. Egg galleries are longitudinal or nearly so, winding, branched, the eggs isolated, the larval mines exposed or concealed in the inner bark, and the pupal cells in the outer bark. It attacks yellow, Arizona, and Chihuahua pines in Mexico, New Mexico, Arizona, and the southern parts of Colorado, Utah, Nevada, and California. It attacks injured trees and prevents recovery. **The Arizona pine beetle,** *D. arizonicus* Hopk., is 3.7 mm. long and dark brown. The egg galleries are transversely winding. It infests yellow pine and has the same distribution as the preceding species. **The southwestern pine beetle,** *D. barberi* Hopk., is 4.5 mm. long, very dark brown or black, and has no long hairs in the elytral declivity. The egg galleries are transversely winding. It commonly attacks yellow pine and, rarely, other pines and Douglas fir. It has the same distribution as the two preceding species. **The Alaska spruce beetle,** *D. borealis* Hopk., is 6 mm. long, wholly black, or with reddish brown elytra. Egg and larval galleries are excavated between the bark and sapwood. It may kill small groups of Sitka, Engelmann, and Canada spruces but is not a serious pest. It occurs in British Columbia and Alaska. **The Sitka spruce beetle,** *D. obesus* (Mann.) (*D. similis* Lec.), is 6–6.6 mm. long and reddish or dark brown to black. It is similar in habits to and often associated with the preceding species in Sitka and Engelmann spruces. The range is from Northern California into Alaska. **The Engelmann spruce beetle,** *D. engelmanni* Hopk., is 6.2 mm. in length, pale brown to dark red

FIG. 419.—Mines of the fir tree destroyer, *Scolytus subscaber* Lec., on white fir. (Photo by H. C. Muzzall.)

or black; the egg galleries short and longitudinal; the larval galleries contiguous for some distance, grooved in wood and deep in the inner bark. It often kills and does much damage to Engelmann and Canada spruces, and ranges in the Rocky Mountains in Mexico, Texas, New Mexico, Arizona, Colorado, Utah, Wyoming, Montana, and eastern Oregon, Washington, and British Columbia. **The western pine beetle,** *D. brevicomis* Lec. (*D. frontalis* Dietz),[1] is 4 mm. long and varies from pale brown to black. It is the most destructive pest to pines in the west and is responsible for tremendous annual losses. In southern Oregon alone it is estimated by A. J. Jænicke [2] that over a ten-year period the loss has amounted to 600,000 acres or $3,000,000. The winter is passed in the middle layers of the bark of newly infested trees, and the adults appear in great numbers from June on. They excavate subtransverse winding egg galleries which cross and recross each other, forming a network between the bark and sapwood in the inner bark or bast layer. The larval galleries penetrate outward into the middle layers of the bark. The eggs are isolated, the larvæ are concealed in the inner bark, and pupal cells occur in the outer bark. The adults emerge through small individual holes which often completely cover the bark after the brood emerges. When healthy trees are attacked, resin tubes form about the entrance holes and are evidences of infestation. A reddening of the foliage follows the emergence of the adults and is an excellent indicator of an infested region. The species attacks healthy trees and is capable of destroying the largest and best timber. It occurs in western parts of Nevada, Wyoming, and Montana, in central and northern parts of California, and throughout Oregon, Washington, and British Columbia, infesting the western yellow pine over practically its whole range. It also attacks sugar pine. **The Jeffrey pine beetle,** *D. jeffreyi* Hopk., is 6–8 mm. long, and dark brown or black. Egg galleries are longitudinal, nearly straight, excavated on the surface of the wood and deep in the inner bark; the larval mines and pupal cells are exposed. It usually attacks dying and dead trees of Jeffrey, yellow, and sugar pines in the mountains of California, Nevada, and Southern Oregon. The colydid beetle, *Deretaphrus oregonensis* Horn, feeds on the larvæ in the burrows.

The western white or mountain pine beetle, *Dendroctonus monticolæ* Hopk.[3] (Fig. 420), is 5–5.6 mm. long and pale brown to black. The adults excavate characteristic straight or winding longitudinal egg tunnels in the inner layers of the bark, and the brood is exposed when the bark is removed. The adults enter the living bark in July and August shortly after emergence from the brood trees. Many emerge from a single exit hole. Infested trees are indicated by pitch tubes and fading yellow or reddish foliage. Living and recently felled trees of white, yellow, lodgepole, and sugar pines are attacked. The species prefers young trees or the tops of old trees where the bark is not too thick, and kills a tree in a single year. It is often a very serious pest and kills as high as 90 to 95 per cent of the trees in some localities. It occurs in Wyoming, Montana, Idaho, Nevada, California,

[1] J. L. Webb, *The Western Pine-destroying Barkbeetle.* Bul. 58, pt. 2, Bur. Ent. U. S. Dept. Agr. 1906.
W. J. Chamberlin, *The Western Pine Bark-Beetle,* Bul. 172, Ore. Agr. Exp. Sta. 1920.
[2] *Jour. Econ. Ent.*, 14, p. 449, 1921.
[3] H. E. Burke, *Proc. Ent. Soc. Wash.*, 21, p. 123, 1919.

Oregon, Washington, and British Columbia. It is specially serious to lodgepole pine in Montana, to white, lodgepole, and yellow pine in the other Northwestern States, and besides attacking these pines, it is the chief enemy of sugar pine in California. **The lodgepole pine beetle,** *Dendroctonus murrayanæ* Hopk., is 5.4–6.9 mm. in length and black with reddish elytra. The adults enter near the base of healthy trees and excavate long egg galleries, depositing the eggs along one side. Pitch tubes occur at the entrance holes. The larvæ excavate a common chamber. This beetle attacks chiefly lodgepole pine and is also recorded by Hopkins on Engelmann spruce. It also occurs in stumps. The range includes the high mountain regions of Colorado, Wyoming, Montana, Idaho, Washington, and British Columbia. **The Black Hills beetle,** *D. ponderosæ* Hopk., is 6 mm. long and varies from brown to black. The egg galleries are usually longitudinal, nearly straight, grooved on the wood and deeply in the inner bark. The entrance holes may or may not have pitch tubes. The larval galleries are short and broad, or long and at right or oblique angles to the egg galleries which, with the pupal cells, are exposed when the bark is removed. It attacks healthy, lightning-struck, and injured trees, kills lodgepole and yellow pines, and also attacks limber pine and Engelmann spruce in the Rocky Mountains of Wyoming, Utah, Colorado, Arizona, New Mexico, Mexico, and extends west into Southern California.

FIG. 420. — Mines of the western white pine beetle or mountain pine beetle, *Dendroctonus monticolæ* Hopkins, on sugar pine. (Photo by H. C. Mazzall.)

The Douglas fir beetle, *Dendroctonus pseudotsugæ* Hopk.,[1] is 4–7 mm. long, and reddish brown with a darker prothorax. The adults appear in March and April and excavate short straight or slightly winding and sometimes branched, longitudinal egg galleries on the inner surface of the wood and deep in the inner bark. There are no pitch tubes at the entrances, but small pitch granules may be present and red dust often gathers below in the crevices of the bark. Injured, dying or dead trees and logs, stumps, dead limbs, and so forth, are preferred, though normal and healthy trees are also attacked. The larval galleries are arranged in fan-shape in groups, alternately from the opposite sides of and at right angles to the egg galleries, or they may arise like the legs of a centipede from the egg galleries. They

[1] W. J. Chamberlin, *The Douglas Fir Bark-Beetle.* Bul. 147, Ore. Agr. Exp. Sta., p. 17, 1918.

are frequently longer than the main gallery and may cross and recross many times. *Tops of infested trees often turn color.* The species is not considered a serious pest in that it does not greatly damage timber, but *loosens the bark and hastens the death of weak trees. It prefers* the Douglas fir, but is also common on bigcone spruce and, rarely, on western larch. The range includes all the region west of the Rocky Mountains from sea level to 8,000 feet and from Mexico into British Columbia.

The red turpentine beetle, *Dendroctonus valens* Lec. (Fig. 421), is the largest western species and is normally pale to dark red, although sometimes *nearly black, cylindrical, and* 5.7–9 mm. long. The egg galleries are generally longitudinal, somewhat winding, variable in length but often very long, irregular in width, sometimes branched and slightly grooved in the surface of the wood and deeply in the inner bark. The eggs are laid in layers at intervals in the tunnels which are packed with sawdust as in the case of all barkbeetles. The larvæ work close together and excavate large continuous chambers, devouring all of the inner bark. Infestation usually occurs near the bases of the trees and rarely more than twenty feet above ground. The beetle attacks healthy trees, killing areas around the bases, or entire trees, but usually healthy trees either recover, or succumb only after prolonged infestations. It commonly breeds in stumps, dying, and dead trees. Practically all kinds of pines are infested. Monterey pine is frequently killed, but yellow pine seldom succumbs to its attacks. Engelmann spruce is also subject to infestation. This species is common throughout North America, excepting the central and southern parts of the United States. It ranges in all the Western States from Mexico into Alaska.

FIG. 421.—Pupæ and pupal cells of the red turpentine beetle, *Dendroctonus valens* Lec., in the inner bark of Monterey pine.

The twig borer, *Phlœosinus cristatus* (Lec.), is 2–2.5 mm. long and pale to dark brown with darker head and prothorax. The adults appear in the spring and summer, commonly bore into the smaller twigs of cypress hedges and ornamental trees at the axils or forks, and cause the tips to die, thus often severely pruning the trees. The larvæ breed under the bark of the twigs and limbs of declining or dead Monterey, Arizona, Guadalupe, Macnab, and ornamental cypresses; Alaska, oriental, incense, and red cedars; Englemann spruce, noble fir, and redwood. The species is indigenous to California and Southern Oregon. **The cypress barkbeetle,** *P. cupressi* Hopk. (Fig. 422), is a similar species which prunes the twigs, and the larvæ mine the inner bark and girdle the twigs of weak Monterey, Sargent, Arizona, Guadalupe, Macnab cypresses; oriental,

incense, and red cedars; and ornamental cypress and cedar in California. **The cedar barkbeetle,** *Phlœosinus dentatus* (Say), is similar to the preceding species. The adults excavate galleries 1 to 2 inches long, parallel with the grain of the wood, and deposit the eggs along the sides. The larval galleries are at right angles to the egg galleries and are quite extensive. The western juniper, Alaska cedar or cypress, and red cedar are attacked. Cedar fence posts are often infested and the range includes California and Oregon. **The western cedar barkbeetle,** *P. punctatus* Lec., infests normal, injured, dead and recently felled trees of the western, incense, red, Alaska, and Lawson or Port Orford cedars, and giant arborvitæ in the high mountains of Colorado, Washington, Oregon, and British Columbia. *P. hoppingi* Swaine and *P. vandykei* Swaine are very small species breeding in the limbs of cedar trees in California. **The redwood barkbeetle,** *P. sequoiæ* Hopk., mines the inner bark of injured, declining, dead, and recently felled redwood and red cedar in California, and red cedar in Oregon, Washington, and British Columbia.

The olive barkbeetle, *Leperisinus californicus* Swaine[1] *(Fig. 423, 424)*, is 3 mm. long, robust dark, the antennæ and legs reddish, the dorsum with a pattern of dark brown or black and white plumose scales, the white forming an indefinite oval on the pronotum and three transverse broken areas on the elytra. The larvæ mine the inner bark and cambium of healthy, injured, and dead olive and ash trees in Southern and Central California. The beetle has been taken from sweepings in the native chapparal in Fresno County by R. Hopping. Young and old olive trees are attacked, but nowhere is the insect yet a pest. **The alder barkbeetle,** *Alniphagus aspericollis* (Lec.) (*Hylesinus*), is 3.5–4 mm. in length and black. It is a common destructive bark miner in living, injured, dying, and recently felled red and white alders in California, Oregon, Washington, and British Columbia. Young trees are preferred, but large trees are often killed.

FIG. 422.—Mines of the cypress barkbeetle, *Phlœosinus cupressi* Hopkins, on the inner bark and sapwood of Monterey cypress. (Photo by H. C. Muzzall.)

The clover root borer, *Hylastinus obscurus* (Marsh.),[2] is 2.2–2.5 mm. long, very small, cylindrical, and dark brown. The adults hibernate in the old larval burrows in clover roots, and appear in the spring to lay eggs in the sides of the crowns and roots of the plants, slightly below the surface. The larvæ feed in the roots and are a serious pest to red clover in many parts of Europe and North America. The species also attacks alsike clover, alfalfa, vetch, beans, and peas, and is destructive in British Columbia, Oregon, Washington, Texas, and Idaho. Short clover rotations and the elimination of volunteer host plants keep it under control.

The grand fir beetle, *Pseudohylesinus grandis* Swaine, is 2.8–3.8 mm. long, stout, black, densely clothed with brown and gray scales, the latter often forming a "V"

[1] E. O. Essig, Bul. 283. Cal. Agr. Exp. Sta., p. 53, 1917.
[2] G. F. Mozenette, Bul. 203, Ore. Agr. Exp. Sta., 1917.

on the elytra. The adults appear in April and construct the primary galleries. The larval tunnels begin at right angles but soon turn parallel to them in the wood and inner bark. The pupal cells occur in the bark. There are one or two broods. The beetle attacks grand and Douglas firs in any stage of growth, and is particularly injurious to saplings and limbs of old trees in a weakened condition. It occurs in Northern California, Oregon, Washington, British Columbia, Idaho, and Colorado. **The larger fir barkbeetle,** *P. granulatus* (Lec.), is 5.5 mm. long and covered with pale and dark scales. It is usually a secondary pest in the trunks and limbs of sickly or recently felled trees, although it does kill young trees. It attacks the grand and Douglas firs in

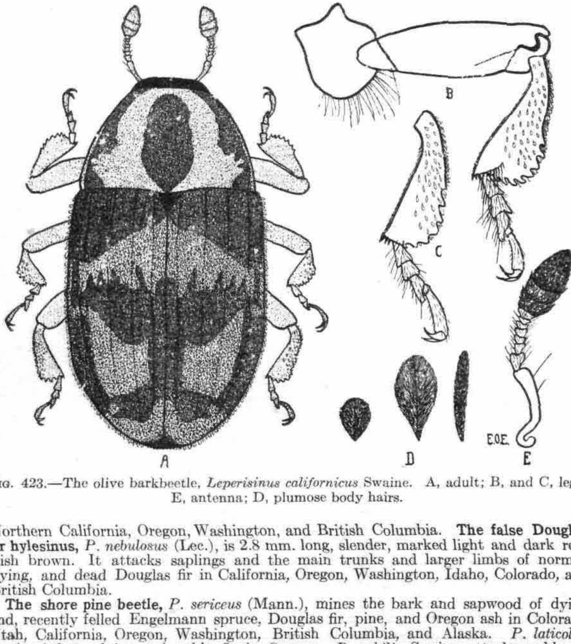

FIG. 423.—The olive barkbeetle, *Leperisinus californicus* Swaine. A, adult; B, and C, legs; E, antenna; D, plumose body hairs.

Northern California, Oregon, Washington, and British Columbia. **The false Douglas fir hylesinus,** *P. nebulosus* (Lec.), is 2.8 mm. long, slender, marked light and dark reddish brown. It attacks saplings and the main trunks and larger limbs of normal, dying, and dead Douglas fir in California, Oregon, Washington, Idaho, Colorado, and British Columbia.

The shore pine beetle, *P. sericeus* (Mann.), mines the bark and sapwood of dying and, recently felled Engelmann spruce, Douglas fir, pine, and Oregon ash in Colorado Utah, California, Oregon, Washington, British Columbia, and Alaska. *P. laticollis* Swaine infests alpine and noble fir in Oregon. *P. nobilis* Swaine attacks noble fir in Oregon.

The Sitka spruce hylurgops, *Hylurgops rugipennis* (Mann.), is 4 mm. long and reddish brown to nearly black. It is of secondary importance and attacks the bark of injured, dying, and recently felled fir, Douglas fir, Sitka and Engelmann spruces, and Monterey, white, and yellow pines in New Mexico, Colorado, Arizona, California, Oregon, Washington, British Columbia, and Alaska. *H. lecontei* Swaine infests lodgepole and yellow pine in New Mexico, Oregon, and British Columbia, Alaska, and probably occurs throughout the entire west. *Hylastes ruber* Swaine infests dead Douglas fir

in British Columbia. **The red fir root borer,** *H. nigrinus* (Mann.), infests the bark of dying and dead trees and stumps of Douglas fir in California, Oregon, Washington, and British Columbia.

The ash tree barkbeetle, *Micracis suturalis* (Lec.) (*Hylesinus aculeatus* Say), is 2.3–3 mm. long, dark brown or blackish, with usually an elongate and diamond-shaped area on the pronotum and three transverse bands on the elytra gray. It infests ash throughout many parts of North America and occurs on Oregon ash in New Mexico, California, and Oregon.

The spruce timber beetle, *Trypodendron bivittatum* (Kirby) (*Xyloterus bivittatus* Kby.), is 3 mm. in length, black, with antennæ, legs, a band on the pronotum and two longitudinal stripes on the elytra yellowish brown. *It is often a serious pest* to injured, dying, recently felled, and fire-scorched trees of spruce, pine, red cedar, larch, hemlock, and fir in Europe, Siberia, and much of North America. In the west it occurs in New Mexico, Colorado, California, Nevada, Oregon, Washington, British Columbia, and Alaska. **The retuse ambrosia beetle,** *Gnathotrichus retusus* (Lec.), is 3.6–3.8 mm. in length. It is an ambrosia beetle, mining the sapwood and heartwood of normal, injured, dying, and recently dead trees, logs, stumps, and large limbs of Douglas fir, western hemlock, and yellow pine in New Mexico, Arizona, California, Nevada, Oregon, Washington, and British Columbia. **The western hemlock wood stainer,** *G. sulcatus* Lec., is a similar species mining the sapwood and heartwood of dying and recently felled western hemlock, Douglas fir, red cedar, and grand fir in Mexico, New Mexico, Calfornia, Oregon, Washington, and British Columbia. **The sugar pine cone beetle,** *Conophthorus lambertianæ* Hopk., infests the cones of sugar pine in California and Oregon and hinders seeding. The adults hibernate in the old cones. *C. ponderosæ* Hopk. infests the cones of yellow pine in Oregon.

FIG. 424.—Portion of dead olive limb showing the mines and exit holes of the olive barkbeetle, *Leperisinus californicus* Swaine.

The western oak barkbeetle, *Pseudopityophthorus pubipennis* (Lec.), mines injured, dying, and recently felled oaks and Oregon ash in California and Oregon.

The densely punctured barkbeetle, *Pityophthorus confinis* Lec., is 3 mm. long, black, and coarsely punctured. It attacks injured, dying, and recently felled Jeffrey pine, yellow pine, and sugar pine in California, Oregon, Washington, and Idaho. *P. nitidulus* (Mann.) is common in dying Sitka spruce and other spruces, pine, and Douglas fir from New Mexico and California along the coast into Alaska. *P. atratulus* (Lec.) (*P. puncticollis* Lec.) (Fig. 425) attacks the twigs and branches of dying and recently felled Sitka spruce, Monterey pine, knobcone pine, yellow pine, lodgepole pine,

and other pines. It ranges in New Mexico, Utah, California, Oregon, Washington, and British Columbia.

The yellow pine wood engraver, *Pityogenes carinulatus* (Lec.), excavates numerous radiating galleries from large central chambers in the bark of living, injured, dying, and recently felled trees, as well as girdling and killing the small twigs of yellow pine in Colorado, California, Nevada, Oregon, Washington, Idaho, and British Columbia.

The lodgepole engraver beetle, *Ips concinnus* (Mann.), is 4.5 mm. in length and elongate with sides parallel. It is very injurious to lodgepole pine and also attacks injured, dying, and recently felled Monterey pine, Sitka spruce, and Douglas fir and ornamental pines in California, Nevada, Oregon, Washington, British Columbia, and Alaska.

The yellow pine engraver, *Ips confusus* (Lec.), is often destructive to young pines, causing most injury in dry years. It sometimes starts at the tops of old trees and attacks living, injured, dying, and recently felled yellow pine in Arizona, California, Nevada, Oregon, Washington, and British Columbia. *Ips emarginatus* (Lec.) attacks the cambium of the middle and lower trunks of living, dying, and dead yellow and lodgepole pines in California, Oregon, Washington, Idaho, and British Columbia. *Ips integer* (Eich.) mines in living bark of lodgepole pine and yellow pine in New Mexico, California, Nevada, Oregon, Washington, Idaho, and British Columbia. **The smaller pine engraver,** *Ips latidens* (Lec.), mines the bark of injured, dying, and recently felled yellow pine and sugar pine in Colorado, California, Nevada, Oregon, Washington, and British Columbia. **The Oregon engraver,** *Ips oregoni* (Eich.), mines lodgepole pine, yellow pine, and white pine in New Mexico, Arizona, California, Nevada, Oregon, Washington, Idaho, and British Columbia. **The western pine engraver,** *Ips plastographus* (Lec.) (Fig. 426, A), is often very destructive to small and large trees of Bishop pine, Monterey pine, and other pines. It often kills large areas of the Monterey pine in California. It also ranges in Arizona and New Mexico. **The Monterey pine engraver,** *Ips radiatæ* Hopk. (Fig. 426, B), is also quite destructive to Monterey pine in California. It usually attacks weakened trees and works from the crown downward. It also infests lodgepole pine and yellow pine, and ranges northward into Oregon, Washington, Idaho, and British Columbia. The green trogositid, *Temnochila virescens* (Fabr.), and the fly, *Lonchæa polita* Say, have been taken from its burrows.

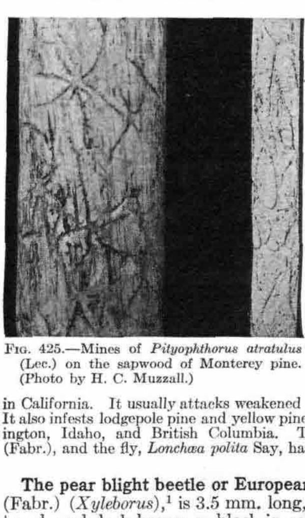

FIG. 425.—Mines of *Pityophthorus atratulus* (Lec.) on the sapwood of Monterey pine. (Photo by H. C. Muzzall.)

The pear blight beetle or European shot hole borer, *Anisandrus dispar* (Fabr.) (*Xyleborus*),[1] is 3.5 mm. long, cylindrical, elongate, strongly punctured, and dark brown or black in color. The males are wingless and the females are winged. The females of the second brood establish new colonies usually in unhealthy or injured trees, although perfectly healthy trees are also infested. Young trees are often completely killed in two or three months. Smaller branches are often killed and the dying of the tips resembles the work of pear blight which has given rise to the common name, rather than any connection of the beetle with the spread or cause of that bacterial disease. The brood chambers are extended into unhealthy or

[1] *Anisandrus pyri* (Peck) is the American name given to this species, but according to Swaine, it is doubtfully distinct from the above, hence the use of the commoner name in economic literature.

dying trees for the purpose of cultivating ambrosia fungi for the feeding of the small white larvæ. The abundant flow of sap of healthy trees kills the eggs and larvæ and stamps out the infestations. This species, therefore, is likely to become more serious whenever the host trees are in need of water and in such cases fruit trees may be seriously injured or killed. Among the common hosts are alder, apple, apricot, ash, beech, birch, cedar, cherry, chestnut, elm, grape, hawthorn, hemlock, maple, oak, peach, pear, pine, plum, pomegranate, poplar, prune, quince, sycamore, tulip tree, and willow. The beetle is European in origin and now occurs in many parts of North America. In the west it is known in California, Oregon, Washington, and British Columbia. The best means to prevent attacks are by keeping the trees vigorous and healthy and burning prunings and refuse.

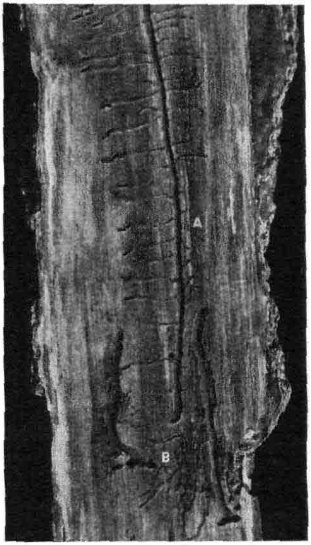

FIG. 426.—Inner bark of Monterey pine showing work of; A, *Ips plastographus* (Lec.); B, *Ips radiatæ* Hopkins.

The lesser shot hole borer, *Xyleborus saxeseni* (Ratz.),[1] is but 2.3–2.5 mm. long, pale brown to black, and cylindrical in form. It is an ambrosia beetle which has habits and hosts similar to the preceding species. Besides fruit and ornamental trees, it commonly infests deciduous and coniferous forest trees. In the west the species is known in New Mexico, California, and Oregon. W. J. Chamberlin[2] lists the beetles, *Colydium lineola* Say and *Enoclerus sphegeus* (Fabr.), as natural enemies.

[1] The eastern *Xyleborus xylographus* (Say) has usually been confused with the above species.
[2] Bul. 147, Ore. Agr. Exp. Sta., 1918. (Complete.)

CHAPTER XXIV

STREPSIPTERA (Order)[1]

(*Strephen*, twist; *pteron*, wing)

Strepsipterans, Twisted-winged Insects, Stylops

This order comprises minute, parasitic insects with complete metamorphosis, and with hypermetamorphoses, larviparous reproduction, winged male, and larviform female. The males are very small averaging from 1.5 to 3 mm. in length, usually cylindrical, black, the head small, eyes large and stalked, antennæ five- or six-jointed and usually branched, the mouth parts rudimentary, the prothorax narrow, the mesothorax bearing a pair of paddle-like vestigial wings or elytra, the metathorax very greatly enlarged and supporting a pair of large milky white wings with radiating veins and which fold lengthwise when at rest. The legs terminate in two, three, or four jointed tarsi, without claws. The adult males are short lived and are exceedingly active, flying with great rapidity among the hosts on which they breed. They are both diurnal and nocturnal. The legless, worm-like females never leave the bodies of the host, and eventually perish with them, but not, however, until they have given birth to living triungulins or first stage larvæ. These are campodeiform with six legs and two anal bristles. They leave the host in quest of the larval stages of new hosts, where they live singly and derive their nourishment by osmosis in the fat body. After the first molt they become soft, legless, and maggot-like, and after several successive molts they finally pupate in the place of abode. The hosts and parasites or stylops develop together and often reach maturity at the same time. The extrusion of a disk-like plate from between the abdominal segments of the host indicates that the parasite is a female, while if the exserted portion is tuberculate and rounded, it is the pupa of a male. Upon reaching maturity the winged male flies away to seek a mate. The female becomes but a great sac filled with eggs which hatch within the body and the triungulins crawl over the body of the host and await an opportunity to gain access to a new larval host.

Although fairly common, these remarkable insects, because of their small size and obscure parasitic habits, are seldom taken even by entomologists. Among the hosts are certain cockroaches and crickets, many kinds of leafhoppers, ants, social and solitary wasps, and gall and stem-dwelling bees. According to Pierce, the Western States are represented by some three families and eleven species. The order offers a splendid field for most interesting study.

[1] W. Dwight Pierce, *A Monographic Revision of the Twisted Winged Insects Comprising the Order Strepsiptera Kirby.* Bul. 66, U. S. Nat. Mus. 1909. "*Strepsiptera. Genera Insectorum*, 121, 1911. "Notes on *Strepsiptera.*" *Proc. U. S. Nat. Mus.*, 40, p. 487, 1911. "Morphology of *Strepsiptera.*" *Proc. U. S. Nat. Mus.*, 54, p. 391, 1919.

CHAPTER XXV

DIPTERA (Order) [1]

(*Dis*, two; *pteron*, wing)

Flies

The adult members of this large order are small insects known as flies. They usually have complex or complete metamorphosis and piercing and sucking or lapping mouth parts, though some aberrant *Dolichopodidæ* have what appear to be incipient mandibles. Normally there is but a single pair of membranous wings and a pair of balancers or halteres, stalked and knobbed organs, instead of hind wings. A few are entirely wingless and some have rudimentary wings. The head is united to the body by a slender neck and has two large compound eyes and usually three ocelli, but some have two, and others none at all. The antennæ are variable in length and shape, consisting of from three to sixteen segments, except in *Cecidomyiidæ* and some aberrant forms in other families which have more than sixteen segments. The body colors are mostly sombre, but some are brightly striped and others have a metallic lustre. The members are usually power-

[1] H. Loew, "Monograph *Diptera* of North America." *Smithsonian Miscl. Coll.*, 1, 1862; 2, 1864; 3, 1872. For other references see Aldrich's *Catalogue of Diptera*, p. 40.

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W. R. Walton, "Glossary of *Diptera*." *Ent. News*, 20, 1909, p. 307.

A. Peterson, "Head-Capsule and Mouth-parts of *Diptera*." *Illinois Biol. Mon.*, 3, 1916, No. 2.

J. R. Malloch, *A Preliminary Classification of Diptera, Exclusive of Pupipara, Based upon Larval and Pupal Characters, with Keys to Imagines in Certain Families*. Pt. 1, Bul. Ill. State Lab. Nat. Hist., 12, 1917, p. 161.

F. R. Cole and A. L. Lovett, "An Annotated List of the *Diptera* of Oregon." *Proc. Cal. Acad. Sci.* (4), 11, No. 15, p. 197, 1921.

C. T. Greene, "Illust. Synopsis of the Puparia of 100 Muscoid Flies." *Proc. U. S. Nat. Mus.*, 60, No. 2405, 1922.

ful fliers particularly the predaceous forms, and with the exception of the nocturnal blood suckers, nearly all are diurnal and sun themselves in various places, frequenting flowers, foliage, fruit, honeydew, exuding tree sap, damp places, filth, and so forth. Eggs are normally produced, excepting in the parastic forms which give birth to living young or to pupæ, and certain forms having larval and pupal pædagenesis. The larvæ, commonly known as maggots, are eyeless; instead of jointed legs they have ventral surface locomotor organs consisting of swellings, paired pseudopods or bristles; with distinct head or lacking the exposed chitinous head covering; and are pointed or blunt at the ends. They are aquatic or terrestrial

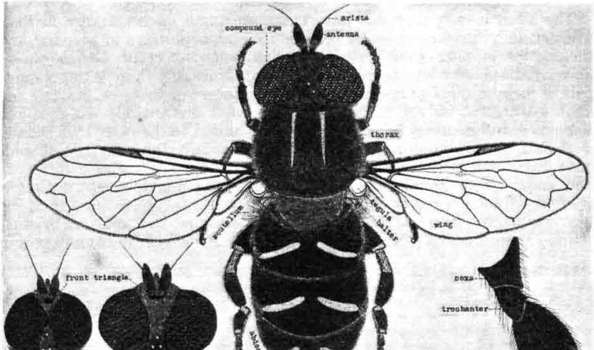


FIG. 427.—The lesser bulb fly or onion fly, *Eumerus strigatus* (Fallén), showing more important body parts.

in habits and feed by piercing and sucking or by chewing. Breathing is usually by spiracles located along the sides of the body or one pair at each end or only one pair at the posterior end, and also sometimes by means of protrusion anal gills. Pupation occurs in a naked condition, in the last larval skin or puparium, or rarely in a cocoon.

The habits of flies are often complicated and exceedingly varied. The adults of many well known aquatic forms, the larvæ of which feed upon decaying vegetable matter and invertebrates frequently doing much good in destroying larvæ of other injurious species, are voracious blood suckers and some are transmitters of serious human diseases as well as persistent tormentors. A large number of species which feed in the larval and adult

stages in carrion, excrement, and filth, spread contagion and transmit terrible diseases to the higher animals and to human beings. A number are parasitic in or on mammals and birds, and several large families are parasitic on insects and other invertebrates. All types of agricultural crops are attacked and great annual losses are sustained through the ravages of those infesting the roots, stems, foliage, fruit, and seeds of economic plants. With the exception of those which pollinate plants and destroy noxious insects and plants, the order is chiefly injurious and by far the most serious to human health and welfare.

KEY TO SUBORDERS AND DIVISIONS

Adults [1]

A. Adults or the pupæ emerging through a T-shaped, longitudinal, or rarely a transverse slit in the larval skin; without a frontal lunule and ptilium; palpi segmented . . . . (Suborder) **Orthorrhapha** p. 526

B. Antennæ relatively long with 7 or more segments; palpi usually with 4 or 5 or rarely 2 segments; larvæ with opposed mandibles . . . . (Division) **Nemocera** p. 526

BB. Antennæ short, variable, usually 3-segmented, the third segment sometimes annulated and with a style or arista; palpi 1- or 2-segmented. Larvæ with vertically moving mandibles (Division) **Brachycera** p. 552

AA. Adults emerging through a circular orifice at the anterior end of the larval skin; frontal lunule present and ptilium usually present. Pupa enclosed in last larval skin . . . . (Suborder) **Cyclorrhapha** p. 563

B. Adults without frontal suture. Larvæ with two to four pairs of chitinized processes which work horizontally and serve the purpose of grasping prey, in addition to the mouth hooks . . . . . . (Division) **Aschiza** or **Athericera** p. 563

BB. Adults with frontal suture and lunule; larvæ with mouth hooks only . . (*Division*) **Schizophora** *p. 574*

C. Squamæ small or vestigial; eyes of male never holoptic; transverse suture incomplete; first posterior cell widely open . . (*Group*) **Acalyptratæ** p. 597

CC. Squamæ well developed; eyes of male holoptic or nearly so; transverse suture complete; subcosta distinct . . . . (Group) **Calyptratæ** p. 574

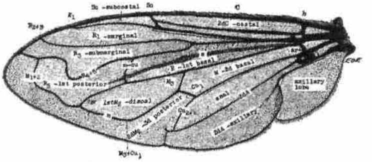
BBB. Adults tough and leathery, apterous or winged; usually ectoparasitic on birds and mammals . . . . (Suborder) **Pupipara** p. 617

The adults according to Malloch do not emerge through a T-shaped slit in the larval skin in the Nemocera, although the pupæ usually do. Possibly by a stretch of imagination one can say that the adults do, but these do not emerge from the pupal skin until long after the larval stage is over, and only if, as in a few cases, they are entirely free from the larval skin in the entire pupal stage.

In the Cyclorrhapha there are no cases where the adults emerge through a true circular orifice. This is more apparent than real as the entire ce-

[1] For keys to adults and also for larvæ and pupæ see J. R. Malloch, *Bul. Ill. Lab. Nat. Hist.*, 12, 1917.

phalic end of the puparium is merely pushed off, but a close examination discloses the fact that there are sutures along the sides and an entire or interrupted suture across the dorsum about one-third the distance from the cephalic extremity that are very often quite conspicuous in the empty puparium, and especially so when there are splits caused by the emergence of the adults. The pupation of this last group takes place within the indurated last larval skin, which is not the case with any of the Orthor-



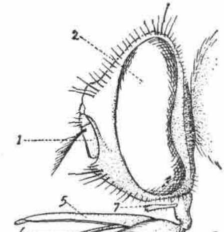


FIG. 428.—Wing of the bulb fly, *Medodon equestris* (Fabr.). The cells are named on the drawing. The veins are: A, anal; 2dA, or 6th longitudinal; ar, arculus; C, costa; Cu, cubitus; Cu_1, Cu_2, and M_3 or 5th longitudinal; h, humeral cross vein; M, media; M_1 and M_2 or 4th longitudinal; M_3, Cu_1 and Cu_2 or 5th longitudinal; m, medial cross vein; m-cu, mediocubital cross vein; R, radius; R_1 or 1st longitudinal vein; R_2 and R_3 or 2d longitudinal cross vein; R_3 and R_4 or 3d longitudinal cross vein; rm, radio-medial cross vein; Sc, subcosta or auxillary.

Head and mouth parts of the stable fly, *Stomoxys calcitrans* (Linn.), showing parts: 1, antenna and arista; 2, compound eye; 3, labrum and proboscis; 4, labella; 5, labrum; 6, hypopharynx; 7, maxillary palpus. (After Herms.) (Also see Fig. 474.)

rhapha except the *Stratiomyiidæ* and these have an entirely different head structure from the Cyclorrhapha.

ORTHORRHAPHA (Suborder)

Straight-seamed Flies

Nemocera (Division)

KEY TO PRINCIPAL FAMILIES

(After J. R. Malloch)

(Figs. 427, 428, 474)

1. Wing with at least 9 veins extending to the margin (exclusive of the anal vein); if there are only 8 such veins the radius is 3-branched, the second branch having its base proximad of the radio-medial cross vein.................. 2
   Wing with less than 9 veins extending to the margin, or the venation not as above 8

2. Mesonotum with a more or less distinct V-shaped suture; male hypopygium generally very large, chitinous; female ovipositor conical, chitinized, and generally protruded.. 3
   Mesonotum without distinct suture, or if there is a poorly defined suture it is not V-shaped.. 5

3. Wing with 2 anal veins.. 4
Wing with 1 anal vein..**Ptychopteridæ**

4. Last palpal joint slender, much longer than the combined lengths of the 3 preceding joints; auxiliary vein terminating in first vein (Crane Flies.) **Tipulidæ** p. 528
Last palpal joint at most but little longer than the combined lengths of the preceding joints; auxiliary vein usually terminating in costa, connected with first vein by a cross vein..**Limnobiidæ**

5. Costa continued around the hind margin of the wing........................ 6
*Costa discontinued at apex of wing........................**Rhyphidæ** (part)*

6. Wing veins without conspicuous scale-like hairs...................**Dixidæ**
Wing veins with conspicuous scale-like hairs................................ 7

7. Wings short and broad, ovate, occasionally pointed apically; tibiæ without apical spurs; small, robust species with rather short densely haired legs (Moth Flies, Owl Midges, Sand Flies.)............................**Psychodidæ** p. 532
Wings elongate, narrow; tibiæ with apical spurs; rather large, slender species, with long, slender, usually moderately hairy or scaly legs (Mosquitoes.) **Culicidæ** p. 532

8. Wing with 2 to 4 distinct longitudinal veins (Gall Midges, Gall Gnats.)......... **Cecidomyiidæ** p. 541
Wing with 5 or more longitudinal veins...................................... 9

9. Wings with a secondary reticulation of fine creases or lines in addition to the veins; slender tipulid-like species with long slender legs (Net-winged Midges) **Blepharoceridæ**
Wings without a secondary reticulation of fine creases, at most with a longitudinal furcate crease between media and cubitus......................... 10

10. Abdomen in both sexes with a conspicuous flap-like scale at base of dorsal surface which is detached posteriorly and fringed with long hairs (Buffalo Gnats, Black Flies.)...**Simuliidæ** p. 551
Abdomen without such basal process.. 11

11. Second basal cell of wing present.. 12
Second basal cell of wing absent... 13

12. Antenna consisting of 2 stout joints, and an apical arista-like one composed of 9 or 10 segments....................................**Orphnephilidæ**
Antennæ composed of 10–11 joints, the apical portion stout, not differentiated, arista-like (March Flies.).................................**Bibionidæ** p. 550

13. Antennæ consisting of 10–11 joints in both sexes (10 if scape is regarded as consisting of 1 joint), the joints of central portion of flagellum shorter than broad; radius and costa conspicuous, the other veins indistinct; at least the mid and hind tibiæ without apical spurs.............................**Scatopsidæ**
Without the above combination of characters................................ 14

14. Coxæ unusually elongated... 15
Coxæ not unusually elongated.. 19

15. Radius with 3 branches; medio-cubital cross vein present.................... 16
Radius with only 2 branches, or if there are three present the medio-cubital cross vein is absent (Fungus Gnats.)...................**Mycetophilidæ** p. 531

16. Radio-medial cross vein present, causing the base of the first posterior cell to be more or less broadly truncate.. 17
Radio-medial cross vein apparently absent, fused with base of third branch of radius so that the base of first posterior cell is acute........................ 18

17. Medio-cubital cross vein much proximad of the radio-medial, causing the posterior portion, divided longitudinally by media, to be much shorter than the anterior portion . . . . **Bolitophilidæ**
Medio-cubital cross vein almost directly in vertical line with the radio-medial, the 2 cells divided longitudinally by media subequal in length **Rhyphidæ** (part)

18. Antennæ short, thick, and often flattened . . . . **Platyuridæ**
Antennæ very long, usually exceeding in length that of body, very slender . . . . **Macroceridæ**

19. Mouth parts chitinized, constructed for piercing, not in the form of a long slender process (Punkies, No-see-ums.) . . . . **Ceratopogonidæ** p. 540
Mouth parts not chitinized, fleshy, sometimes in the form of a long slender process 20

20. Radius with 2 branches (Root Gnats.) . . . . **Sciaridæ** p. 531
Radius with 3–4 branches, if less or indistinct the antennal joints with very long plumes in the male and very conspicuous constrictions between them in the female (Midges, Gnats.) . . . . **Chironomidæ** p. 540

TIPULIDÆ.[1] Crane Flies.

These are very small to large, slender, long-legged, brown or gray flies, with from six to thirty-nine antennal segments, four- to five-segmented palpi, and V-shaped mesonotal suture. The females are easily separated from the males by the sharp ovipositors. It is a very large family and only a few of the more interesting forms are noted.

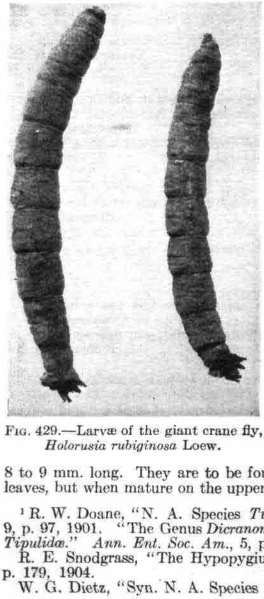


FIG. 429.—Larvæ of the giant crane fly, *Holorusia rubiginosa* Loew.

The thick-legged snow gnat, *Chionea valga* Harris, is a wingless spider-like species 5 mm. long and yellowish brown in color. The femora of the hind legs are enlarged. They appear in the snow in early spring and range from New York to British Columbia. In the west they are found at high altitudes. *C. nivicola* Doane is a similar species, 4 mm. long and reddish brown, which occurs on the snow in eastern Washington.

The leaf-eating crane fly, *Cylindrotoma splendens* Doane[2] (*C. juncta* Coq.), is a small, pale yellow and black, alate species 9–10 mm. long, which appears the last of May in Alaska and British Columbia. The females insert the whitish, elongate-oval eggs into slits in the lower epidermis of the leaves of the false bugbane which grows in the damp, shady woodlands. The larvæ are greenish when mature and from 8 to 9 mm. long. They are to be found when young, feeding on both surfaces of the leaves, but when mature on the upper sides only. They move by looping the body, eat

[1] R. W. Doane, "N. A. Species *Tipulidæ*." *Jour. N. Y. Ent. Soc.*, 8, p. 182; 1900; 9, p. 97, 1901. "The Genus *Dicranomyia*." *Ent. News*, 19, p. 5, 1908. "New Western *Tipulidæ*." *Ann. Ent. Soc. Am.*, 5, p. 41, 1912.
R. E. Snodgrass, "The Hypopygium of the *Tipulidæ*." *Trans. Am. Ent. Soc.*, 30, p. 179, 1904.
W. G. Dietz, "Syn. N. A. Species *Tipulidæ*." *Ann. Ent. Soc. Am.*, 6, p. 461, 1913.

[2] A. E. Cameron, *Ann. Ent. Soc. Am.*, 11, p. 67, 1918.

large holes in the leaves, and hibernate in a half-grown condition on the ground under the dead leaves. They begin feeding as soon as the foliage appears on the host plants in the spring. Pupation occurs on the leaves, the adults emerging after the middle of May. There is but one brood.

The wood-boring tipulid, *Ctenophora angustipennis* Loew, is black and yellowish red, the head and antennæ black, the wings pale amber, the abdomen yellowish red with a continuous black stripe, and the length 17 to 25 mm. The larvæ are dirty brownish white, 39 mm. long and 5.2 mm. in diameter. The eggs are black. This species inhabits wet, decaying wood, and according to A. L. Lovett [1] often bores into the wet, dead areas in prune trees in Oregon. It also occurs in British Columbia, Washington, and California.

The giant crane fly, *Holorusia rubiginosa* Loew [2] (Fig. 429), is the largest western tipulid as well as the largest western dipteron, the length of the body averaging from

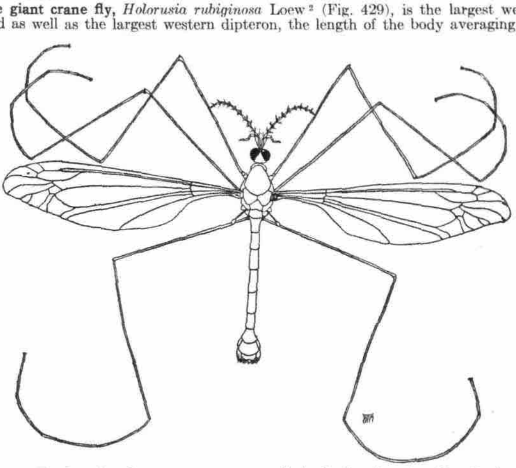


FIG. 430.—*Tipula pubera* Loew, a common crane fly in the San Francisco Bay Region, California. (After Woodworth.)

25 mm. for the male to 35 mm. for the female and the wing expanse from 55 to 75 mm. The color is a uniform reddish brown, somewhat duller on the thorax where there are also white lateral and ventral markings. The legs are unusually long and easily torn from the body. The large dull brown larvæ vary from 30 to 55 mm. in length and are

"The Hebes Group." *Trans. Am. Ent. Soc.*, 40, p. 345, 1914. "Rev. N. A. *Pachyrhina.*" *Trans. Am. Ent. Soc.*, 44, p. 105, 1918.

C. P. Alexander, "Biology N. A. Crane Flies." *P. C. Jour. Ent. and Zoöl.*, 6, p. 105, 1914; 7, pp. 1, 141, 1915; 11, p. 67, 1919. "The Crane Flies of New York." *Mem. Cornell Agr. Exp. Sta.*, pt. I, 25, p. 771, 1919; pt. II, 38, p. 699, 1920.

C. P. Alexander and J. T. Lloyd, "Biology of N. A. Crane Flies." *P. C. Jour. Ent. and Zoöl.*, 6, p. 12, 1914.

In his recent book, J. H. Comstock includes the superfamily *Tipuloidea* with the families *Tanyderidæ* or primitive crane flies, *Ptychopteridæ* or phantom crane flies, *Anisopidæ* or false crane flies, and *Tipulidæ* or typical crane flies.

[1] *Second Bien. Crop Pest & Hort. Rept.*, 1913–1914, Ore. Agr. Exp. Sta. 1915, p. 166.

[2] V. L. Kellogg, Anatomy of Larvæ. *Psyche*, 9, 1909, pp. 207, 246.

semi-aquatic or aquatic in habits, living in leaf mold, grass roots, trash, or mud, in the bottoms or around the edges of pools and creeks. It is a Pacific Coast species ranging from British Columbia to Southern California and also reported from Idaho.

The acute crane fly, *Tipula acuta* Doane, is a large species, 15 to 25 mm. long, grayish with a conspicuous dark brown, longitudinal line on the dorsum of the abdomen, and several small, dusky spots and a large, oblique white mark near the tips of the wings. It is a very common species often very abundant in late summer and fall, the females ovipositing in the dry soil in Washington, Oregon, and California. The eggs are oval and pale brown. The larvæ are typical leather jackets and feed on the roots of grasses and succulent plants, including the tubers of dahlias, wherever decay occurs. *T. præcisa* Loew closely resembles the former in size and color and occurs in California. *T. angustipennis* Loew is reported by R. A. Cooley as abundant in Montana.[1] *T. derbyi* Doane is a small yellow species, 12–13 mm. long, with slightly smoky, hyaline wings. The larvæ feed on the roots of grasses and grain in California.

The range crane fly, *Tipula simplex* Doane[2] (Fig. 431), is one of the most destructive species in California. The adult females are practically wingless with only small wing stubs, grayish brown, rather short-legged, and 10–13 mm. long, while the males are winged and 8–10 mm. long. The eggs are elongated, black and 0.08 mm. long. They are laid in the ground during the spring and summer months. The larvæ are 18–25 mm. long, pale brown, and rather roughened. The pupæ are more flattened and with two horn-like projections at the anterior end. The larvæ appear in January, February, and March, often in countless numbers, in pastures, grasslands, and grain fields. They live in small round holes from which they emerge nights and dull days to feed upon the green vegetation. They are not abundant every year, but in some favorable mild and wet seasons they often denude vast areas of grasslands and grain, particularly barley. They also at times injure alfalfa. In the spring great numbers of adult males and females often congregate in large numbers under rocks or other objects on the grassy hillsides. A white fungus kills great numbers of the larvæ and pupæ, and blackbirds and kill deers devour great numbers of them. Very effective control measures have been worked out by Packard and Thompson consisting in the use of the regular grasshopper poison bran mash consisting of 25 pounds of bran, 1 pound of Paris green, and

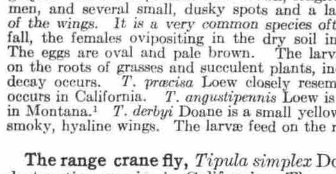


FIG. 431.—Winged male and apterous female of the range crane fly, *Tipula simplex* Doane. (After Carnes and Newcomer.)

[1] *Twelfth Rept. Ent. Mont.*, Bul. 102, Mont. Agr. Exp. Sta. 1914, p. 197.

[2] Also known as the alfalfa crane fly.

R. W. Doane, *Jour. N. Y. Ent. Soc.*, 9, 1901, p. 103. Orig. desc. *Ent. News*, 18, 1907, p. 15; 19, 1908, p. 437.

E. K. Carnes and E. J. Newcomer, *Mthly. Bul.*, Cal. Hort. Com. 1, 1912, p. 279.

E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d, ed. 1915, p. 318.

C. M. Packard and B. G. Thompson, "The Range Crane-flies in California." *Dept. Circ.* 172, U. S. Dept. Agr. 1921.

about 3 gallons of water. It should be separated into small particles and evenly distributed over the infested areas. *T. quaylii* Doane is often associated with the former and similar in size and color, but both male and female have only vestigial wings.

MYCETOPHILIDÆ. Fungus Gnats.[1]

This is a family of small, slender, delicate, mosquito-like flies which move rather quickly over damp, secluded places and which are readily distinguished by the elongated coxæ. The eggs are laid in fungi and in wet, decaying wood and other vegetable matter. The larvæ are usually slender, 12-segmented, footless, smooth, whitish with brown or black chitinized head, and eight pairs of spiracles. They live in fungi, damp soil, decayed wood or other vegetable matter. Some are often serious pests to cultivated mushrooms and are controlled by cleaning and screening the beds.

Mycomya mendax Johannsen is 6 mm. long, yellow and black. The larvæ feed on decayed wood and fungi. The range is from British Columbia to California, including Idaho. *Leia nigra* Johannsen is 4 mm. long and shining black with yellow markings on the venter and legs. The larvæ infest mushrooms in Washington. *L. striata* Williston is 5 mm. long, with the head and thorax yellow and abdomen black. The larvæ live in mushrooms in Washington, California, and Wyoming. *Mycetophila scalaris* Loew is 3 mm. long and yellowish with darker markings. It infests boletus and polyporus in the east, and ranges west to British Columbia. *M. fallax* Loew is 3 to 3.7 mm. long, and dark brown to black. It occurs on fungi in California. *M. pectita* Johannsen is 3.5 mm. in length, dusky yellow and dark brown. It occurs on fungi in British Columbia and Washington. *M. punctata* Meigen is brownish and 4–6 mm. long. It is the commonest species throughout the country. In the west it infests various toadstools and mushrooms, including the edible *Stropharia semiglobata* Batsch, as well as *Coprinus* and *Locellina* in California. It is also reported from Idaho and Wyoming. *M. mutica* Loew is a very small reddish yellow or fuscous species, 2.7 mm. long, which is also a common and widely distributed species throughout North America. The larvæ infest mushrooms and toadstools. It is known in British Columbia, Washington, California, and Wyoming in the west.

SCIARIDÆ.[2] Root Gnats.

These gnats are closely related to the preceding family in which they were formerly included. They differ in having the coxæ much less elongated, and by the wing venation, "the R-M cross vein being in the same right line with the second section of the radial sector, and the cubitus forking near the base of the wing." (Johannsen.) The larvæ live largely on decayed vegetable and organic materials but many species infest the roots and tubers of plants and do some damage, particularly in the warm humus soils of greenhouses. **The fickle midge,** *Sciara inconstans* Fitch, is 2 mm. long, and shining black with pale femora. The larvæ are reported as infesting purple locoweed in Colorado.[3] Johannsen thinks the western forms are prob-

[1] O. A. Johannsen, *The Fungus Gnats of N. A.*, Buls. Maine Agr. Exp. Sta. I, Bul. 172, 1909; II, Bul. 180, 1910; III, Bul. 196, 1911; IV, Bul. 200, 1912. "*Mycetophilidæ.*" *Genera Insectorum*, 93, 1909.

E. Guthrie, "New *Mycetophilidæ* from Cal." *Ann. Ent. Soc. Am.*, 10, 1917, p. 314.
R. S. Sherman, "British Columbia *Mycetophilidæ*." *Proc. B. C. Ent. Soc.*, 1919, p. 12; 1920, p. 16.

[2] O. A. Johannsen, *Sciarinæ*. Bul. 200, Maine Agr. Exp. Sta., 1912, p. 111.
F. W. Pettey, "Revision of Genus *Sciara*." *Ann. Ent. Soc. Am.*, 11, 1918, p. 319.
This family is retained in *Mycetophilidæ* by J. M. Aldrich.

[3] F. H. Chittenden, Bul. 64, pt. V, Bur. Ent. U. S. Dept. Agr., 1909, p. 36.

ably *S. prolifica* Felt,[1] which also occurs in British Columbia and California. *S. pauciseta* Felt is 2 mm. long and shining black with yellow markings on legs. It has been reared from decayed choke cherries in British Columbia, orange and lemon twigs in California, and gooseberries in New York. **The clover crown midge,** *Neosciara trifolii* Pettey *(Sciara)*,[2] is a small black species 1.2 to 1.5 mm. long, closely related to the preceding midge and has been reared by A. C. Burrill from the crowns of red clover in Idaho.

PSYCHODIDÆ.[3] Moth Flies, Owl Midges, Sand Flies.

These are very small, hairy, brownish or dark flies resembling brown lacewings or small moths. The wings are usually folded roof-like and, rarely, horizontally over the body. The adults are nocturnal and frequently come out of the sink drains in which the larvæ live in a semi-aquatic environment. Some species live under water. The larvæ feed on algæ or on decayed vegetable matter. The adults of some tropical and subtropical species are bloodsuckers and serious enemies of humans, as they are vectors of fevers and other diseases. Some also feed on reptiles. Our western forms are aquatic or breed in decayed vegetable matter and dung and all are non-injurious so far as known.

Psychoda pacifica Kincaid is 2–2.3 mm. long, brown, with the wings folded roof-like when at rest. It is a common Pacific Coast species ranging from Alaska to Southern California. The larvæ have been reared from manure. The species also breeds in cesspools[4] and drains, the adults emerging into wash basins and sinks. *Pericoma bipunctata* Kincaid is brown clothed with white hairs. It also ranges from Alaska to Southern California.

CULICIDÆ.[5] Mosquitoes.

The adults are small, slender, long-legged, frail flies characterized by the scaly wings, complete marginal wing vein, and absence of ocelii. They are of great economic importance not so much because of their bloodsucking habits, but rather because of the transmission of such serious diseases as malaria, yellow fever, and filariasis. The original food, however, of both males and females is supposed to have been plant juices. The larvæ are aquatic, living under a great variety of conditions such as deep lakes, shallow, clear or permanent running streams, or stagnant, temporary pools or ditches. They are usually elongated with head and thorax well-developed, body somewhat hairy, with the respiratory organs often as elongated tubular spiracles on the penultimate abdominal segment. Some of the forms living in deep water have air sacs in the thorax and tip of the abdomen permitting them to remain continuously under water. They are vegetarian, feeding on minute particles of decaying materials

[1] O. A. Johannsen, Bul. 200, Maine Agr. Exp. Sta., 1912, p. 139.

[2] F. W. Pettey, *Jour. Econ. Ent.*, 11, 1918, p. 420. *Ann. Ent. Soc. Am.*, 11, 1918, p. 334.

[3] L. Haseman, "Mon. N. A. *Psychodidæ*." *Trans. Am. Ent. Soc.*, 33, 1907, p. 299, S. W. Williston, "N. A. *Psychodidæ*." *Ent. News*, 4, 1893, p. 113.
T. Kincaid, "*Psychodidæ* of Pacific Coast." *Ent. News*, 8, 1897, p. 143; 10, 1899, p. 30.
T. J. Headlee and C. S. Beckwith, "Sprinkling Sewage Fly." *Jour. Econ. Ent.*, 11, p. 395, 1918.

[4] E. Gemmell, *P. C. Jour. Ent. and Zoöl.*, 13, 1921, p. 1.

[5] L. O. Howard, *The Mosquitoes of U. S.* Bul. 25 n. s. Div. Ent. U. S. Dept. Agr. 1900. "Key to Known Larvæ of Mosquitoes of U. S." *Circ.* 72, Bur. Ent. U. S. Dept. Agr.

or predaceous on very small aquatic animals. The movements are such as to give rise to the common name "wrigglers." The pupæ have conspicuously swollen thoraces, trumpet-like respiratory organs well back on the disk of the thorax, and with 2 or 4 flat, paddle-like organs for swimming. They are quite active and are called "tumblers" because of their quick, odd movements. The adults escape directly from the pupal skins on the surface of the water. The eggs are very small, elongate or oval, and laid singly or in masses or in rafts on the water or on the mud. Breeding may or may not continue throughout the summer. In most species the adults hibernate in hollow logs, culverts, deserted buildings, or under bridges, and appear in the spring. In some species, however, the eggs are laid in the summer or fall and hatch with the melting of the snow in the spring. There are many natural enemies consisting of fish and predaceous water insects which feed on the larvæ and pupæ, while dragonflies are the most important enemies of the adults. Their efficiency is handicapped by the fact that while most mosquitoes are nocturnal, the dragonflies are diurnal. Day mosquitoes are readily taken, and on summer days dragonflies can be seen busily at work almost up to dark. Artificial control has proved thoroughly successful and has made healthful many malarial and fever-ridden districts. The organization of malaria abatement districts is an effective means of ridding large areas of malaria mosquitoes in California. Eliminating the breeding places by ditches and by preventing the overflow and accumulation of waste irrigating water is fundamental wherever possible. Where this cannot be done, oiling is resorted to with great effectiveness. Small mosquito-eating fishes are also valuable in permanent breeding places.

There are many species in the west and space permits of only the briefest discussion of the family. The classification follows Dyar.

Members of the large genus *Culex* are especially abundant in the tropical and warmer temperate areas with few ranging into the cold northern regions. The eggs are laid on the surface of the water, in irregular shaped, compact rafts by overwintering females. The individual eggs are somewhat cigar-shaped and 0.7 mm. long. The rafts appear as masses of soot on the water. The larvæ inhabit permanent water under natural

1906. *Preventive and Remedial Work Against Mosquitoes.* Bul. 88, Bur. Ent. U. S. Dept. Agr. 1910.

L. O. Howard, H. G. Dyar, and F. Knab. *The Mosquitoes of North and Central America and the West Indies.* 4 vols. Carnegie Inst. of Wash. 1912.

E. P. Felt, *Mosquitoes of N. Y.* Bul. 79 (Ent. 22), N. Y. State Mus. 1904.

D. W. Coquillett, "Classification of Mosquitoes of North and Middle America." *Tech. Ser.*, 11, Bur. Ent. U. S. Dept. Agr. 1906.

H. J. Quayle, *Mosquito Control.* Bul. 178, Cal. Agr. Exp. Sta. 1906.

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W. B. Herms, "Malaria." *Special Bul.*, 9, Cal. State Bd. Health, 1916. "Mosquitoes." In *Med. and Veter. Entomology.* Macmillan, 1923, p. 103.

T. D. A. Cockerell, "The Mosquitoes of Colorado." *Jour. Econ. Ent.*, 11, 1918, p. 195.

E. Hearle, "Notes on British Columbian Mosquitoes." *Proc. B. C. Ent., Soc.*, 1921, p. 132.

H. G. Dyar, "The Mosquitoes of U. S." *Proc. U. S. Nat. Mus.*, 62, 1922, p. 1. "The Mosquitoes of Canada." *Trans. Royal Can. Inst.*, 13, 1921, p. 71.

H. G. Dyar and F. Knab. Many articles, *Insec. Insc. Menst.*, Vols. 4, 1916, to present date.

The writer is indebted to S. B. Freeborn for reviewing the manuscript of this family.

and artificial conditions and the adults are often abundant and troublesome biters in the country, towns, and cities. Many species transmit diseases of birds and animals, but do not carry serious human diseases except filariasis in the tropics. The hum is often very high-pitched and loud. *Culex anips* Dyar is a small, blackish species, with dark reddish mesonotum, white spots on the lateral basal abdominal segments, and the femora white beneath. It is reported only from extreme Southern California. *C. apicalis* Adams (*C. saxatilis* Grossbeck, *C. fricki* Ludlow, etc.) [1] is a small dark species with white bands on the apices of the abdominal segments. The larvæ breed in grassy marshes or in surface pools and ditches under the protection of willows or bushes. The adults are often common but feed on cold-blooded animals, like frogs, and not on humans. The species occurs throughout Europe and North America. In the west it occurs in New Mexico, California, and north to British Columbia. **The house mosquito,** *Culex quinquefasciatus* Say, is a pestiferous medium-sized, reddish brown mosquito, the larvæ of which breed in ponds, old wells, rainbarrels, cans, and artificial receptacles. It is a common tropical mosquito ranging far up into the Eastern States, but occurs only in Arizona, the Imperial Valley and occasionally in the Southern San Joaquin Valley, California. **The European house mosquito,** *Culex pipiens* Linn. (*C. consobrinus* Rob.-Desvoidy, etc.), is also a medium-sized, reddish brown species with entirely dark wing scales. It prefers artificial receptacles for breeding, but the larvæ also occur in pools polluted by animal refuse. It is cosmopolitan, having been introduced into the temperate regions. In the west it ranges from New Mexico and California into British Columbia and Alaska. **The little black or white dotted mosquito,** *Culex territans* Walker (*C. restuans* Theobald, *C. brehmei* Knab), is a medium-sized, reddish brown mosquito with the proboscis and legs wholly dark, and pale brown rings at the ends of the tarsal joints. It is a house-infesting species which breeds in dirty puddles and artificial receptacles. It is reported only in California in the west, but occurs throughout the country east of the Rocky Mountains. *Culex erythrothorax* Dyar is a medium-sized, reddish species with integument and scales of the mesonotum red. The larvæ live in permanent ponds, and rest on the surface upon reeds in Southern California. **The common mosquito,** *Culex tarsalis* Coquillett (*C. kelloggi* Theobald, etc.), is a medium-sized species, blackish or brownish with bronzy scales and narrow, silvery line on each side of the mesonotum. Its most characteristic marking is the white band at the middle of the proboscis and dark V-shaped markings on the venter of the abdomen. The abdomen has white, basal rings on the segments, the tarsi have white rings on both ends of the joints, and the wing scales are dark and hairlike, forming a little tuft at the base of the third vein. The larvæ live in marshes, pools, river beds, in the grass at the edges of lakes, in irrigation ditches, and in brackish water near the sea. The adults are persistent biters and readily enter houses. It is primarily a western species known in British Columbia, Washington, Oregon, California, Idaho, Nevada, Arizona, Montana, and Colorado. It is the commonest mosquito in California. **The white-banded mosquito,** *Culex stigmatosoma* Dyar, is very similar to the preceding species. The white rings on the tarsi are wide on the hind legs and narrow on the others, and the V-shaped, dark abdominal markings are replaced by median spots. It breeds in stream beds, pools, fountains, barrels, and horse troughs, where the water is more or less permanent. It is tropical ranging through Mexico into California and Southern Oregon.

The species of *Theobaldia* (*Culiseta*) are large mosquitoes inhabiting temperate regions. The eggs are laid in compact rafts on the surface of the water by overwintering females. The larvæ inhabit permanent water; a few, however, readily breed in artificial receptacles. The adults attack humans, horses, and cattle, but are sluggish biters. There are but few species. **Dyar's mosquito,** *Theobaldia dyari* (Coquillett), is a large dark brown species with broad white bands at the bases of the abdominal segments and the tarsi with faint whitish rings at both ends of the joints. The larvæ appear in the spring in cold bogs of Alaska, British Columbia, Canada, and Northern United States. **The Alaska mosquito,** *Theobaldia*

[1] This species has been confused with *C. territans* Walker in the west. S. B. Freeborn considers *C. apicalis* Adams as the proper name.

alaskaënsis (Ludlow), is very large and blackish, and separable from the former by the white rings which occur only at the bases of the tarsal joints. The larvæ live in grassy marshes in river valleys and the adults hibernate, appearing in the spring to lay the eggs on the surface of the water. The adults bite humans, but are seldom sufficiently numerous to be serious. The species ranges from Siberia and Alaska into British Columbia and Montana. **The rainbarrel mosquito,** *Theobaldia incidens* (Thomson) (*Culex*, *C. particips* Adams), is a large dark mosquito with spotted wings, the abdomen with basal segmental white bands, the tarsi with narrow white basal rings. The adults hibernate. The egg rafts are narrow. The larvæ inhabit permanent ditches, swamps, dirty and clear pools, brackish water, and are often found in rainbarrels, hence the common name. The adults are lazy and apparently bite humans less than horses and cattle. It is a western species known west of the Rocky Mountains from New Mexico to Alaska. It is one of the commonest species in California and a ready biter in this State. **The snow mosquito,** *Theobaldia impatiens* (Walker), is a very large, dark brown species with two wide paler lines on the mesonotum, mouth parts black, basal segmental white bands, wing scales black, coarsely linear, and wanting on the cross veins. The adults inhabit chiefly thinly wooded areas and mountain slopes, and are rarely troublesome. During winter hibernation they often appear on warm winter days. The eggs are laid in somewhat triangular rafts on the surface of the water in the spring. The larvæ live in permanent, dark forest pools and are extensively preyed upon by the phantom culicid larvæ of *Pelorempis americana* (Johannsen). The species ranges over much of this country and is known in Alaska, British Columbia, Washington, Montana, Oregon, and California, but is most abundant in the northern forests. **The broad-winged mosquito,** *Theobaldia inornatus* (Williston) (*Culex*, *C. magnipennis* Felt), is also a very large, dark brown species with mouth parts brown, two bare, paler brown lines on the mesonotum, pale yellow basal segmental lines on the abdomen, and broad wings with linear blackish scales. The adults hibernate and are much more troublesome to large mammals than to humans. The eggs are laid in elongated rafts. The larvæ live in permanent water and not in artificial receptacles. The distribution is general throughout the country and includes all of the west from the Rocky Mountains to the Pacific and from New Mexico and Southern California into Montana and British Columbia.

Members of the small genus *Tæniorhynchus*[1] are chiefly tropical. The adults are large and with the wing scales distinctly large and broad. The eggs are laid in compact rafts on the surface of the water where water plants suitable for feeding are growing. The larvæ are exceptional in that the air tube is adapted for piercing the submerged stems and roots of aquatic plants from which they secure oxygen for breathing. They are usually thus anchored to plants and do not come to the surface after hatching. But one species, *T. perturbans* (Walker), occurs in the west. It is a large brownish species with the tarsi conspicuously ringed with broad white bands at the bases of the joints, and wings densely covered with broad white and brown scales intermixed. The adults are very painful biters and will fly several miles from their breeding grounds in search of food. They readily invade houses. The winter is passed in the half-grown larval stage attached to stems and roots of sedges and other aquatic plants in permanent pools and marshes, usually in timbered regions. The species ranges throughout North America and is recorded in the west in Montana and, rarely, in British Columbia.

[1] *Mansonia* of some American authors.

Psorophora signipennis (Coquillett) (*Tæniorhynchus, Grabhamia*) is the chief representative of a small genus of large and showy mosquitoes with scaly legs. They are severe biters being able to penetrate considerable thicknesses of clothing, and may be carriers of disease. This is a genus of tropical and temperate America. The eggs are spinose and laid singly on the mud of drying pools or on the dry bottoms of rain pools where they may remain dry much of the time during summer and winter and for periods of several years. They hatch after successive rains, not all hatching at any one time, and the wrigglers mature very quickly in four or five days. The larvæ of some species of the genus are predaceous on other wrigglers. The adults of the above species are medium-sized and yellowish with spotted wings. The species is primarily a prairie form in arid regions west of the Rocky Mountains ranging from Texas, New Mexico, and Arizona to Montana.

The genus *Aëdes* embraces many species, living in great numbers in the tropic, temperate, and arctic regions throughout the world. The adults are for the most part medium-sized or small, often exceedingly abundant and severe biters. The yellow fever mosquito and closely related forms of the tropics are the only members which carry human diseases, being supposed to transmit yellow and dengue fevers and filariasis. After laying eggs, the adults die off. The winter is passed in the egg stage. The eggs are black, spindle-shaped, and laid singly in the mud, tree holes, or other places where water collects, in which stage the winter is passed. The species are found under varying conditions in the tidelands, river valleys, and the higher altitudes and regions of snow and ice. In any case, after a period of dormancy the eggs hatch when submerged by the rains or melting snows of the spring, the larvæ developing rapidly and the adults issuing in a remarkably short space of time. A visit to the high mountains or to the colder northern regions when the snow is melting soon convinces the early camper or vacationist that the proper way to escape being literally eaten up by mosquitoes, is to defer visits to such regions until after the snow is all gone at the campsite, for no amount of battling, nets, or ointment will preserve the peace of mind of one who thus sallies forth to the haunts of mountain trout and snow mosquitoes. *Aëdes pullatus* Coquillett is a medium-sized black species, the mesonotum yellowish or whitish. The larvæ are found in muddy pools along streams and lakes and are late developing. The males swarm over brush around water on late afternoons or after sunset. The species occurs from Alaska through British Columbia into Idaho, Montana, Wyoming, and Colorado. In the southern ranges it frequents high altitudes. *A. intrudens* Dyar, *A. diantæus* Howard, Dyar and Knab, and *A. punctor* Kirby are all medium-sized black mosquitoes inhabitating the northern forest areas from the Atlantic to the Pacific. All are troublesome. *A. punctodes* Dyar is apparently confined to Alaska. *A. leuconotips* Dyar and *A. cyclocerculus* Dyar are black forms close to *A. communis communis* (De Geer) and *A. punctor* Kirby. They range from Alaska to British Columbia, the larvæ developing in the muskeg pools along the Pacific Coast. *A. aboriginis* Dyar is a similar species ranging from Alaska to Washington, and breeding in foul pools in the deep forests where the adults bite day or night. *A. hexodontus* Dyar is also similar to the foregoing species, the larvæ appearing after the snow is all gone in shallow pools in marshes, meadows, or along streams in the mountains of Oregon and California. The adults bite in daylight in shady places, but appear in greatest numbers at nightfall. *A. idahoënsis* Theobald is a small dark gray species inhabiting the open plains country, avoiding

timber, in Montana, Colorado, Idaho, Washington, British Columbia, Nevada, and Utah. *A. æstivalis* (Dyar) [1] is a small gray western species with dark brown mesonotum, preferring the wooded areas of Montana, Idaho, Washington, and British Columbia. *A. aldrichi* Dyar and Knab is similar with yellowish mesonotum. It inhabits the wooded river bottoms. The larvæ live in flooded alder bottoms and are the dominant species in such localities. The females are severe biters. The mosquito ranges on both sides of the Rocky Mountains in Montana, Wyoming, and Colorado and westward into Idaho and British Columbia. It is often a serious pest in the Fraser River Valley.[2] *A. impiger* (Walker) is a small blackish forest species close to *A. communis communis* (De Geer), the larvæ developing in the early spring pools in the northern forests of Alaska, British Columbia, Washington, and the High Sierras of California, and east to the Atlantic Coast. *A. cataphylla* Dyar is similar in appearance and habits ranging from Alaska into British Columbia, Idaho, Montana, Wyoming, and the Sierras of California. *A. niphadopsis* Dyar and Knab is related to the two previous forms. The larvæ inhabit brackish pools on the eastern shore of Great Salt Lake, Utah.

The common snow mosquito, *Aëdes communis communis* (De Geer), is a fairly large, black, common and pestiferous snow mosquito of the higher altitudes in the Western States or in the valleys of the far north. The larvæ develop in ground pools in the mountain meadows and forests, formed by melting snow in the spring. The adults bite day and night and are horrible tormentors to early visitors of the higher altitudes in June and July. The typical form ranges in the northern forests from the Atlantic to the Pacific and is known in Montana and Alaska. Many localized races are recognized as follows: *A. communis altiusculus* Dyar occurs at Mount Rainier, Washington; *A. communis masamæ* Dyar tortures July visitors at Crater Lake, Oregon, as the writer can well testify for 1923; *A. communis tahoensis* Dyar ranges throughout the Sierras of California.

The brown salt marsh mosquito, *Aëdes dorsalis* (Meigen) (*Culex curriei* Coq., *C. lativittatus* Coq., *A. quaylei* Dyar and Knab), is one of the most common and troublesome species along the Pacific Coast. The adults are small, yellowish gray with the tarsi banded white, the mesonotum with a diffused median brown stripe, the abdomen with grayish white basal segmental bands and a longitudinal dorsal line forming dark paired quadrate spots along the back, and the tarsi with pale rings at both ends of the segments. The species inhabits low dry areas and moist coastal plains. The larvæ live in ground and rock pools, brackish water, and salt marshes. The adults are often carried by the wind into towns and cities, and bite persistently after sunset. It is practically a cosmopolitan species. In the west it is known in nearly all of the areas, having been reported in British Columbia, Washington, Oregon, California, Nevada, Utah, Idaho, Montana, Wyoming, Colorado, and New Mexico.

The field mosquito, *Aëdes campestris* Dyar and Knab, appears much like the preceding species and bites day and night, the larvæ inhabiting mineral pools and brackish water often in company with it. Although localized it is often very abundant and ranges from Alaska through British Columbia

[1] Probably a synonym of *A. hirsuteron* (Theobald) an eastern species.
[2] *Can. Ent.*, 53, 1921, p. 48.

into Idaho, Utah, Montana, and eastward. *A. canadensis* (Theobald) and *A. excrucians* (Walker) are woodland species which inhabit the northern forests from the Atlantic to the Pacific, the former in Montana and British Columbia, and the latter in British Columbia and Alaska in the west. *Aëdes increpitus* Dyar is a small black species with ringed tarsi, inhabiting the forest regions of the Sierras of California and Nevada. *A. mutatus* Dyar is a race of the former found in Washington, Idaho, Utah, Montana, Wyoming, and Colorado. *A. fitchi palustris* Dyar is a large blackish species with ringed tarsi, which is the western representative of *A. fitchi* (Felt and Young). The larvæ live in early marsh pools and the adults fly in the forests until late fall in the Coastal mountains of California, Oregon, Washington, British Columbia, and Alaska.

The California salt marsh mosquito, *Aëdes squamiger* (Coquillett) (*Culex*), is a rather large brownish gray species with ringed tarsi. The larvæ inhabit salt marshes and tide pools along the coast of middle and southern California. The adults invade cities and towns, particularly in the San Francisco Bay region and are persistent and severe biters at dusk on warm summer and fall days. *A. varipalpus* (Coquillett) (*Culex, Tæniorhynchus sierrensis* Ludlow), is a beautiful, small black mosquito with white ringed tarsi. It inhabits forests. The adults are annoying but usually rare. The males swarm about the hosts awaiting the females. The larvæ breed in tree holes and artificial receptacles. The species ranges along the Pacific Coast from British Columbia to Southern California, and east to the summit of the Sierras and into Arizona. *A. tæniorhynchus* (Wiedemann) (*Culex, C. damnosus* Say), is a small dark species with white-banded proboscis, often present in great numbers throughout North America. The larvæ live in brackish tide pools along the coast. It is reported only from Southern California in the west. *A. nigromaculis* (Ludlow) (*Grabhamia, G. grisea* Ludlow) is a rather large blackish species with bronzy yellow mesonotum and white ringed tarsi. It is a plains and prairie mosquito, the adults being severe biters. The larvæ develop in waste irrigating and rain pools. The species occurs in New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, and Arizona.

The vexatious mosquito, *Aëdes vexans* (Meigen), has a host of synonyms and has often been wrongly determined. The adults are medium-sized, brown, the abdomen black with basal segmental white rings, narrow white basal tarsal rings, and wholly dark wing scales. The adults are often abundant in woods and thickets and are severe biters. They are rarely found in the open or at high altitudes. The larvæ breed in pools formed by rain or overflow from floods or irrigation ditches. The mosquito is common throughout much of North America and in the west occurs in New Mexico, Colorado, Wyoming, Montana, Idaho, Arizona, California, Oregon, and British Columbia. In the latter province it breeds in alder bottoms, according to E. Hearle. *A. cinereus* Meigen is a small blackish mosquito with much the same appearance and habits as the former. It ranges in Colorado, Montana, British Columbia, Washington, Oregon, and California in the west. *A. ventrovittis* Dyar is a small black species inhabiting the Sierras in California and Mount Rainier in Washington. It is a fierce day biter, appearing early in the season, and probably breeds in snow water.

The malaria mosquitoes which belong to the genus *Anopheles* are so called from the fact that nearly all of them are vectors of that disease. They are chiefly inhabitants of the tropical and warmer temperate regions throughout the world and rarely occur in the far north. The adults are roughly distinguished from other common mosquitoes by the long palpi in both sexes, the straight proboscis, the simple scutellum which is not lobed, and the peculiar habit of tilting the body at a considerable angle in biting. They are voracious bloodsuckers and are capable of flying long distances in search of food. Flight is chiefly at dusk but they are also known to bite in broad daylight. The hum is very low pitched as compared with many other mosquitoes. Hibernation in our area is usually in the adult stage in hollow trees, culverts, under bridges, and so forth. The eggs are fusiform with rounded ends and furnished with longitudinal leaf-like appendages of various shapes as floats. They are laid singly on the surface of the water and float. The larvæ are surface feeders and lie horizontally attached to the surface film by the fan-shaped abdominal tufts and by the characteristic short air tube. This position is in sharp contrast to that of other mosquito wrigglers which assume a position at a distinct angle to the surface. In feeding on the small algæ and minute animal matter, the head is turned completely over so that the mouth is up. They inhabit fresh, brackish, and salt water, frequenting still, permanent ground pools, edges of slow and swift streams, or, rarely, tree holes and water holding leaves of certain plants.

The woodland malaria mosquito, *Anopheles punctipennis* (Say), is a medium-sized brown mosquito with hairy mesonotum which is whitish in the integument in the middle and dark brown on the sides, the legs long and blackish with small whitish spots on the tips of the femora and tibiæ, wing scales black with a large yellow spot on the outer third of the costa, and three smaller spots. The larvæ inhabit transient puddles and permanent water of ditches, pools, and swamps in shaded locations. The species ranges throughout much of North America and is reported in British Columbia, where it is abundant during the wet season, Oregon, California, and New Mexico in the west. In California it is most often found along the Sierra foothills, where it is not abundant in any locality. It bites out of doors and on porches but rarely invades houses. It is of less importance as a malaria carrier.[1]

The wayside anopheline, *Anopheles pseudopunctipennis* Theobald (*A. franciscana* McCracken), greatly resembles the preceding species but is not closely allied to it. It is of medium size, blackish with white spotted wings and gray abdomen. There are yellowish white knee spots and white rings at the bases of the palpi joints. The larvæ inhabit ground pools and the edges of streams. The adults are often abundant and may be carriers of malaria. The species occurs in the southwest, being reported in Texas, New Mexico, and California, and extends southward as far as the Argentine.

The European malaria mosquito, *Anopheles maculipennis* Meigen (*A. occidentalis* Dyar), is the most important malaria mosquito in the Western States. It is a medium-sized blackish species with black spotted wings and a characteristic conspicuous bronzy patch at the apex of the wing fringe. The entirely black palpi readily distinguish it. The larvæ breed in places

[1] W. B. Herms, *Jour. Econ. Ent.*, 14, 1921, p. 413.

similar to the breeding spots of the preceding species. According to S. B. Freeborn,[1] "this is the holarctic species extending from northern Europe through Alaska and Canada and dipping into the United States along the Pacific slope, at various points along the northern border, and into New England where it overlaps with *A. quadrimaculatus* (Say) in Massachusetts." The lattter species does not exist in the far west. In California, according to Herms[2] and Freeborn,[3] this species is most common in the Sacramento and San Joaquin Valleys, but also occurs throughout the State. There are ordinarily two generations. The adults hibernate, appear in February, and begin to lay eggs in March. The adults of the first brood reach the peak in June and those of the second brood, in September. There are probably three or four broods in some places. The adults readily enter houses and are the important carriers of malaria. The western distribution includes Alaska, British Columbia, Washington, Oregon, California, Nevada, Utah, Montana, and Colorado. The species is less abundant in the more northern sections.

The mosquito destroyer, *Pelorempis americana* (Johannsen) (*Eucorethra underwoodi* Coquillett),[4] is distinguished from the true species of the mosquitoes, which the adults very much resemble, by the short proboscis which is not adapted for piercing. The larvæ are transparent and glass-like, with elongated antennæ armed with three strong spines, and well developed mandibles with two stout and several smaller teeth each. The thorax has eight tufts of feathered hairs on each side and the abdomen, seven, while the anal segment and appendages resemble those of *Anopheles*. These destroyers are predaceous on the larvæ of various species of mosquitoes including *Theobaldia incidens* (Thomson), among which they live. The adults are yellowish with reddish markings. This species is known in New England and British Columbia. What appears to be the same species has been taken by the author at Berkeley, California.

CHIRONOMIDÆ and CERATOPOGONIDÆ. Midges, Gnats, Punkies, No-see-ums.[5]

This is a family of small to minute species, mosquito-like in form but which are distinguished by their smaller size, the absence of body and wing scales and the habit of the true chironomids of resting with the front legs raised. The eggs are laid singly in clusters on aquatic objects in wet decaying vegetable matter, or are imbedded in gelatinous strips. The larvæ

[1] *Bul. Brooklyn Ent. Soc.*, 18, p. 158, 1923.

[2] W. B. Herms, *Jour. Econ. Ent.*, 14, p. 413, 1921.

[3] S. B. Freeborn, *Jour. Econ. Ent.*, 14, p. 415, 1921.

[4] According to Aldrich the combination is either *Pelorempis americana* (Johan.) or else *Eucorethra underwoodi* Underwood. Underwood in *Science*, August 7, 1903, mentioned the new genus and species as manuscript names of Coquillett. Then Johannsen published before Coquillett.

O. A. Johannsen, Bul. 68, N. Y. State Mus., p. 402, 1903.

D. W. Coquillett, *Can. Ent.*, 35, p. 272, 1903.

[5] The punkies and no-see-ums are placed in a separate family *Ceratopogonidæ* by J. R. Malloch. They include the bloodsucking species and differ from the true *Chironomidæ* in having the thorax only slightly arched and not overhanging the head. J. M. Aldrich retains all under the latter family.

Bul. 64, pt. 3, Bur. Ent. U. S. Dept. Agr. 1907.

Bul. Ill. State Lab. Nat. Hist., 12, 1917, pp. 281, 284.

H. F. Carter, "Rev. of Genus *Leptoconops*." *Bul. Ent. Research*, 12, 1921, p. 1.

are minute, slender, and whitish or red in color. They have a bunch of hooks beneath the head and a paired hook-like process at the tip of the abdomen where the tracheal gills are also located. They live in wet decaying vegetable matter or in flowing sap of plants on land or in water and feed on decaying plant and animal matter. Many of the adults are harmless, while others are thirsty bloodsuckers, among the most pestiferous to animals and human beings. They bite during the day and are often so numerous and vicious as to be almost unendurable.

Members of the genus *Chironomus* have white and red larvæ which are often troublesome in the water systems of our western cities simply by their presence. The adults do not bite, but often appear in such numbers as to almost smother residents in the immediate vicinity of marshes, rivers, and lakes. *Metriocnemus edwardsi* Jones [1] is yellowish brown in the adult form and 4 mm. long. The small, pale yellow elongated eggs are 0.22 mm. long. The larvæ are brownish white with darker head, with four retractile blood gills on the twelfth segment, and 7 mm. long. They inhabit the leaves of the California pitcher plant and feed on the moist insect remains therein.

The bloodsucking gnat or no-see-um, *Leptoconops torrens* (Townsend) (*Tersesthes*),[2] is a small rather slender black gnat 1.5 to 2 mm. long with very faint wing veins. In California this species appears along the rivers in April, May, and June, and is a vicious and persistent bitter and especially bad on dull hot days or in the shade in bright sunny weather. In Southern California and the interior valleys it is the most troublesome. The species was originally reported from high altitudes in New Mexico as a pest to horses.[3] It also occurs in Utah, Colorado, Arizona, and Texas. Associated with this species is the closely related *L. americanus* Carter (*L. kerteszi* var. *americanus* Carter), which occurs throughout the Sacramento Valley, California, and is also known at Salt Lake, Utah. It is a fierce biter and apparently the commonest form in Northern California. *Culicoides sanguisuga* (Coquillett) (*Ceratopogon*) is a specially bloodthirsty species in British Columbia and Oregon. *C. biguttatus* (Coq.) occurs also in Oregon. *Forcipomyia cilipes* (Coq.) ranges from Alaska to Oregon. *Ceratopogon guttipennis* Coq. and *C. stellifer* Coq. occur in Arizona. The former is gray with mottled wings and a serious biter. The latter also inhabits New Mexico and with *C. variipennis* Coq. and *C. unicolor* Coq., occurs in northwestern California.

CECIDOMYIIDÆ (*Itonididae*).[4] Gall Midges, Gall Gnats.

This family comprises minute slender fragile flies, the larvæ of which are largely plant feeders, many producing galls in which they live. Among

[1] *Ent. News*, 27, 1916, p. 385.
[2] Determined by Henry F. Carter and J. R. Malloch.
[3] C. H. T. Townsend, *Psyche*, 6, 1892, p. 370.
[4] E. P. Felt, "Hosts and Galls of Am. Gall. Midges." *Jour. Econ. Ent.*, 4, 1911, p. 451.
"The Gall Midge Fauna of Western N. A." *P. C. Jour. Ent.*, 4, 1912, p. 753.
"A Study of Gall Midges." *N. Y. State Mus. Buls.* and *Repts.*, State Ent. N. Y. I, Bul. 165, 28th Rept. 1913, p. 127; II, Bul. 175, 29th Rept. 1915, p. 79; III, Bul. 180, 30th Rept. 1915, p. 127; IV, 31st Rept. 1916, p. 101; V, 32d Rept. 1918, p. 101; VI, 33d Rept. 1918, p. 76; VII, 34th Rept. 1921, p. 81.
"Key to Am. Insect Galls." *N. Y. State Mus. Bul.*, No. 200, 1917.
"New Western Gall Midges." *Jour. N. Y. Ent. Soc.*, 24, 1916, p. 175.
J. J. Kieffer. *Genera Insectorum. Fasc.* 152, 1913.
Family name also spelled *Cecidomyidæ*.

the plant-infesting forms are very serious crop pests such as the Hessian fly and the wheat midge which are responsible for great losses to the wheat growers of the United States and Canada. The great majority, however, live on native plants and are of no economic importance. The galls produced are often very characteristic and either serve as a specific character in determining the species or greatly aid in the task. Some live as inquilines in the galls, a few in excrement of insects, mammals, and birds, and a number of species are predaceous on red spiders, mites, plant lice, psyllids, scale insects, and other small animals. The adults are readily distinguished by the characters in the key to the families. The larvæ are 14-segmented and "many species possess a sternal spatula or breast-bone projecting from the first thoracic segment." Pædogenesis, the parthenogenetic reproduction of the larvæ which give birth to similar larvæ, occurs among some of the gall midges. The family is a very large and interesting one. The western species are numerous and there is much to be learned concerning the habits and economic status of the many known and unknown species. It is to be regretted that only the more interesting species can be included.

FIG. 432.—The woolly galls of *Diarthronomyia flocculosa* Felt on California sage or artemisia.

The wild rye midge, *Rhabdophaga elymi* Felt, infests wild rye in the San Francisco Bay region, California. The adult females are reddish brown and 2 mm. long. *R. racemi* Felt is also a reddish brown species, 1.25 to 1.50 mm. long. The larvæ inhabit small clustered rosette or cone-like galls on the twigs of willow. The midge ranges from Southern California to Manitoba. *R. brassicoides* (Walsh) forms green cabbage-shaped galls in clusters on the tips of the twigs of willows, particularly on the topmost shoots. The galls are also conical in shape and from 6–20 mm. long. The small white larvæ, 2–3.5 mm. long, inhabit a single central cell in the gall and transform into adults in the spring. The species occurs throughout the country and in Colorado, New Mexico, and Arizona in the west.

The clover flower midge, *Dasyneura leguminicola* (Lintner) (*Cecidomyia trifolii* Lint.),[1] is a well known injurious species throughout the east and middle west. It ranges west into British Columbia and Oregon, and probably throughout much of the entire area. The adults are minute fragile

[1] E. P. Felt, 29th *Rept. State Ent. N. Y.* 1915, p. 172.
A. L. Lovett, 2d *Bien. Crop Pest & Hort. Rept. Ore. Agr. Exp. Sta.* 1915, p. 157.
G. F. Mozenette, Bul. 203, Ore. Agr. Exp. Sta. 1917.
This species is not to be confused with the European *D. trifolii* Loew which is well established in this country but not yet reported in the west.

dark brown and reddish midges, about 1.5 mm. long, with ovipositor longer than the body. The minute orange eggs are laid in the green flower heads of red and white clover in early spring and hatch in about a week

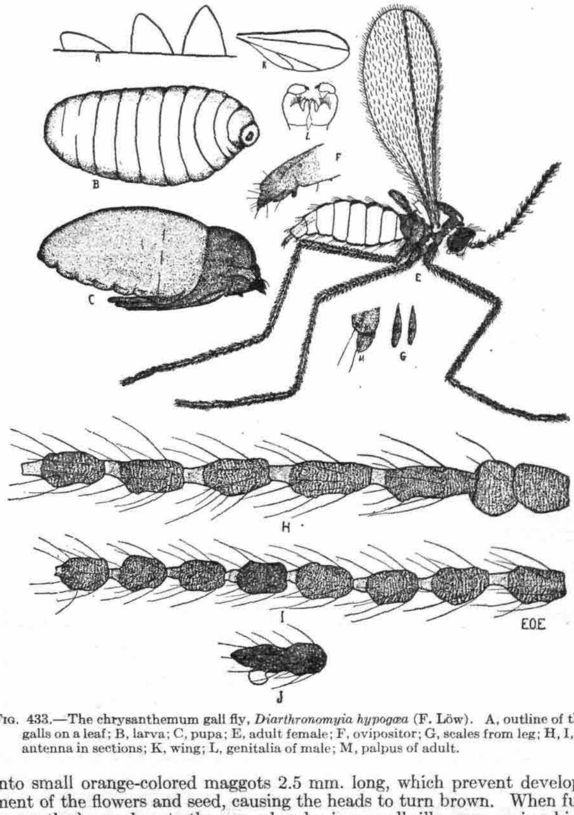

FIG. 433.—The chrysanthemum gall fly, *Diarthronomyia hypogæa* (F. Löw). A, outline of the galls on a leaf; B, larva; C, pupa; E, adult female; F, ovipositor; G, scales from leg; H, I, J, antenna in sections; K, wing; L, genitalia of male; M, palpus of adult.

into small orange-colored maggots 2.5 mm. long, which prevent development of the flowers and seed, causing the heads to turn brown. When full grown the larvæ drop to the ground and spin a small silken cocoon in which to pupate. There are two broods annually. This insect is a very serious

menace to the production of red and white clover seed, while alsike and mammoth clover and alfalfa are not affected. In many sections of the country seed production is impossible. In Oregon it is the most serious pest to red clover seed in the Willamette Valley. Control measures consist in eliminating volunteer plants or in preventing their blooming, and by mowing the hay crop two weeks early to prevent development of the maggots, saving the next crop for seed. *D. lupini* Felt is 2.5 mm. long, dark brown, with the ovipositor as long as the body. It produces fleshy, irregular, pale green fusiform polythalamous galls 15 to 25 mm. in length on the stems of lupines in the San Francisco Bay region, California. *D. pergandei* Felt has a reddish larva which infests and swells the fruit of wild cherry in Colorado. The galls are conical, and red and green in color. *D. gemmæ* Felt produces diminutive apical bud galls on willow in Utah and *D. californica* Felt, bud galls on willow in California.

The artemisia gall midge, *Diarthronomyia artemisiæ* Felt, produces a variable globose bud, rosette, or bladder leaf gall on artemisia in Utah and Colorado; *D. californica* Felt produces brownish or reddish sub-conical galls at oblique angles on the undersides of the leaves of artemisia in California; *D. flocculosa* Felt (Fig. 432) produces irregular, densely white, woolly, confluent woody galls 4–6 mm. in diameter, often appearing as elongated masses on the small stems of artemisia in California. *D. occidentalis* Felt produces oval, pubescent, thin-walled galls 1 mm. long, vertical or oblique, on the undersides of the leaves of artemisia and wormwood in California and Utah.

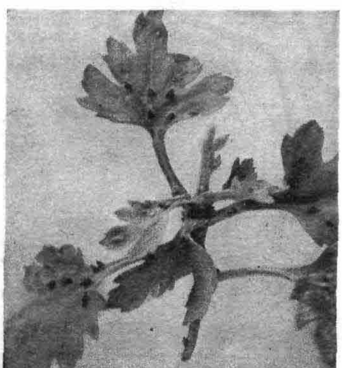

FIG. 434.—Galls of the chrysanthemum gall fly, *Diarthronomyia hypogæa* (F. Löw), on chrysanthemum leaves.

The chrysanthemum gall fly, *Diarthronomyia hypogæa* (F. Löw),[1] (Figs. 433, 434), is an interesting greenhouse pest to chrysanthemums in various parts of the United States. The adults are delicate, brownish, with bright red abdomen, and are 1.5 mm. in length. The tiny, slender, bright red eggs are laid in clusters often in great numbers on the leaves, buds, and developing tips of the plants. The maggots vary from white or yellow to orange, and average about 1.5 mm. in length. They produce very small elongated or cone-shaped, hard-walled, green or reddish, oblique or vertical galls on the upper surfaces of the leaves and on the stems and tips of the shoots, singly or in dense masses. The individual galls are 1 mm. long. The galls may be so abundant as to distort and ruin the developing buds. The species does not injure chrysanthemums grown out of doors, unless

[1] E. O. Essig, *Jour. Econ. Ent.*, 9, 1916, p. 461.

protected by some shelter. This species occurs throughout California and is also reported in British Columbia,[1] Washington, and Oregon in the west. The parasite, *Amblymerus justicia* Girault, is quite common at Berkeley, California. Control measures consist in spraying with nicotine or weak oil emulsions to kill the eggs, or cutting and burning the tops of the host after blooming each fall, or whenever the host is found to be infested.

Lasioptera verbeniæ Felt causes cylindric swellings on the stems of verbena in California. *Neolasioptera trimera* Felt produces stem galls on the sunflower in Arizona.

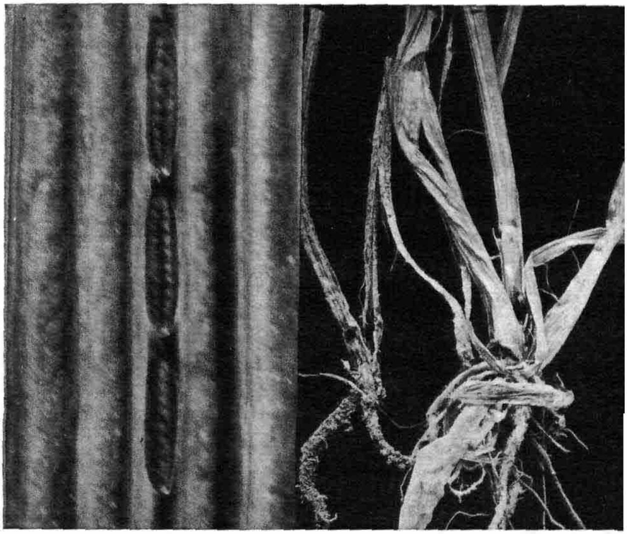

Fig. 435.—Wheat plants showing injury by the larvæ of the Hessian fly, *Phytophaga destructor* (Say). The pupæ or flaxseeds of this insect are also plainly visible on the stems. At the left are shown three eggs, very greatly enlarged, on a wheat leaf.

Asteromyia grindeliæ Felt makes an oval blister leaf gall 3–4 mm. in diameter on gum plant in California.

The Hessian fly, *Phytophaga destructor* (Say) (*Cecidomyia, Mayetiola*) (Fig. 435), in the adult stage is minute, fragile, dark or reddish brown

[1] R. C. Treherne, *Agr. Jour.*, Victoria, B. C., 1, 1916, p. 168.
[2] E. J. Wickson, Bul. 58, Cal. Agr. Exp. Sta. 1886.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed, 1915, p. 321.
E. P. Felt, 30th *Rept. State Ent. N. Y.* 1915, p. 212. Biblio.
C. M. Packard, *Mthly Bul.*, Cal. Hort. Com. 7, 1918, p. 174.

2 to 3 mm. long. The eggs are cigar-shaped, 0.5 mm. long, and reddish in color. They are laid in the late winter and spring on the upper surfaces of the leaves, and hatch in from 4 to 12 days. The larvæ are white with greenish median stripe, and 2 mm. long. They feed in the stems causing them to break in the mature summer plants and killing the infested tillers of the young early spring plants. They are full grown in three weeks and pupate between the leaf sheaths and the stems of the bases or lower joints of the plants, the last larval stage being the small mahogany red puparia known as flaxseeds. From the resting flaxseed stage the larvæ become pupæ and eventually adult flies. In the Eastern and middle Western States there are two distinct broods, one in the spring and another in the fall, but in the west as in England there appears to be but one early spring and a partial second late spring brood. The summer, early fall, and winter are passed in the larval flaxseed stage. Pupation occurs early in the spring and adults appear in January and February, but mainly in March. Eggs are laid on the young wheat and barley and the larvæ begin to work on the small plants just above the crown. The flaxseed stage is normally reached before harvest and usually the larvæ escape destruction in the stubble where the summer and early winter is passed in safety. The presence of the insect can be most easily ascertained by examining the bases of unhealthy looking patches or individual plants for the flaxseeds which are easily found, though partially hidden under the leaf sheaths just above the crown.

FIG. 436.—Galls of *Rhopalomyia californica* Felt on chapparal broom.

The common name is derived from the belief that the insect was introduced into America by the Hessian soldiers stationed on Long Island, New York, during the Revolutionary War. J. R. Malloch believes that "there is another explanation of the origin of the name Hessian Fly. It was customary about the time of the War of Independence to call anything of a reprehensible nature Hessian and the name was thus applied to the fly which had at that time started to injure crops just as the Hessians injured the Americans." Wheat, barley, and rye are attacked. In the west the fly is recorded from Washington, California and Oregon. It has been known in California since 1885 and while troublesome in small areas, it has never been regarded as a real pest. In Oregon it is often serious in the Willamette Valley and other wheat-growing sections west of the Cascades. Control

measures consist in plowing the stubble deep immediately after harvest, summer fallow, crop rotation, and early sowing to get vigorous growth for spring plants.

Phytophaga californica Felt infests currant in California. *Janetiella coloradensis* Felt produces regular oval swellings 4 to 5 mm. long at the bases of the needles of pine in Colorado. *Rhopalomyia baccharis* Felt makes nearly flattened or elongated swellings on the tips of the shoots of chapparal broom in the San Francisco Bay region, California. *R. californica* Felt causes nearly globular green and red galls 10–25 mm. in diameter on the tips of the shoots of chapparal broom, often in company with the former. Both species are heavily preyed upon by undetermined parasites. *R. crassulina* (Ckll.) produces short oval galls 7 mm. long, densely covered with white hairs, and singly or in pairs sessile on the branches of wild aster in Colorado. *R. sabinæ* Felt

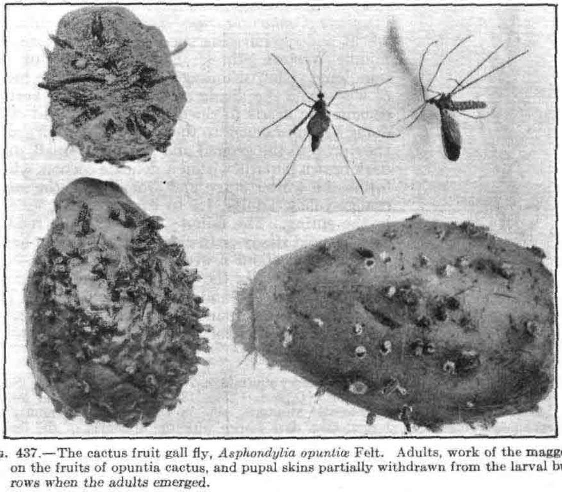

FIG. 437.—The cactus fruit gall fly, *Asphondylia opuntiæ* Felt. Adults, work of the maggots on the fruits of opuntia cactus, and pupal skins partially withdrawn from the larval burrows when the adults emerged.

produces conical, purplish, thick-walled, apical bud galls 10 x 3 mm. on juniper trees in Colorado and Utah. The gall splits in four sections when the adults emerges. *R. salviæ* Felt causes conical, grayish brown, thick-walled galls 10 x 6 mm. on the middle and margins of the leaves of wild sage in California.

The alfalfa gall midge, *Asphondylia websteri* Felt,[1] infests the floral heads of alfalfa causing the seed pods to become swelled and bloated. The adults are 2.25 mm. long and dark brown. It is at times a serious pest to

[1] F. M. Webster, *Circ.* 147, Bur. Ent. U. S. Dept. Agr. 1912.
G. F. Freeman, Bul. 73, Ariz. Agr. Exp. Sta. 1914.
E. P. Felt, *Jour. Econ. Ent.*, 10, 1917, p. 562.

alfalfa seed in limited areas in Arizona and New Mexico and was first wrongly determined as the European *A. miki* Wachtl.

The cactus fruit gall fly, *Asphondylia opuntiæ* Felt [1] (Fig. 437), is a small gray species, 4 mm. long in the adult form. The larvæ are white and 5 mm. long. They are often present in great numbers in the green and ripening fruits of opuntia cactus. In escaping, the frail brown pupal skins are left with the ends still in the exit holes. The species is common in Southern California, Arizona, Colorado, New Mexico, Texas, and Mexico. *A. arizonensis* Felt and *A. betheli* Cockerell also infest the fruit of opuntia in the southwest. The former is recorded as forming galls greatly resembling cactus fruits, which is apparently a case of mistaking the fruit for a gall. It occurs in California, Arizona, and Colorado. The latter is known only in Colorado.

FIG. 438.—Shoot of Monterey pine showing shortened needles with swollen bases due to the work of the Monterey pine midge, *Thecodiplosis piniradiatæ* (Snow and Mills).

The wheat midge, *Thecodiplosis mosellana* Gehin (*Diplosis, Contarinia tritici* Kirby),[2] is the common wheat and rye infesting species of the Eastern and middle Western States. The larvæ are stout, 2.5 mm. long, yellowish orange, and inhabit the heads of wheat and rye, living on the developing kernels causing the heads to ripen prematurely, and often doing serious damage to the crop. When full grown they drop to the ground and pupate in small, oval, dark brown puparia within a delicate cocoon, which forms the winter stage and from which the small orange-yellow adults, 1.5 to 2.5 mm. long, emerge in the spring. The minute, slender, pale, reddish eggs are laid singly or in clusters in the grain heads and hatch in about a week. There is but a single brood annually. In the west this midge is reported only in British Columbia and Washington. The puparia are often found in the chaff as well as in the ground. Control measures are the same as for the Hessian fly.

The Monterey pine midge, *Thecodiplosis piniradiatæ* (Snow and Mills) (*Diplosis*)[3] (Fig. 438), is a common and serious pest to the Monterey pine in California. The adults are 1 mm. long, dark brown with the abdomen of the female reddish. They appear from January to March and lay the minute, elliptical, light yellow or orange colored eggs singly or in masses of several to 25 on the terminal buds. They hatch in about 2 weeks and the orange-colored larvæ, 1 to 1.5 mm. long, begin work at the bases of the needles where they feed until November and December. The injury is evidenced by the shortened yellowish needles which may or may not be swollen at the bases. In cases of heavy infestation the trees are practically denuded and appear fire swept, with serious results to their health. According to H. Compere [4] pupation does not occur in the burrows as was previously supposed, but in

[1] E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 318.
[2] E. P. Felt, *Jour. Econ. Ent.*, 5, 1912, p. 286.
J. J. Davis, *Circ.* No. 82, Purdue Agr. Exp. Sta. 1918.
[3] W. A. Snow and Helen Mills, *Ent. News*, 11, 1900, p. 489. Orig. desc.
W. A. Cannon, *Am. Nat.*, 34, 1900, p. 801.
E. P. Felt, 33d *Rept. State Ent. N. Y.* 1918, p. 123.
[4] *Mthly. Bul.*, Cal. State Com. Hort., 4, 1915, p. 574.

the soil, and cultivation around the trees has been demonstrated in Golden Gate Park, San Francisco, as an efficient and practical means of control for ornamental trees. The

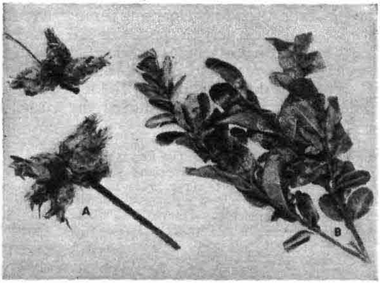

FIG. 439.—Gall midges. A, the willow cone gall produced by *Rhabdophaga racemi* Felt on willow in Southern California; B, blister-like galls or mines in leaves of ornamental boxwood produced by the larvæ of the box leaf midge, *Monarthropalpus buxi* Lab.

big cone, digger, Bishop, knobcone, and other pines, and the Monterey cypress are infested to a much less degree. The distribution is largely limited to the natural range of the Monterey pine along the Pacific Coast of middle California. *T. cockerelli* Felt produces irregular, kidney-shaped enlargement of pine needles in Colorado. *Contarinia coloradensis* Felt and *Dicrodiplosis gillettei* Felt produce apical bud galls on bull or yellow pine in Colorado.

The California pitch midge, *Retinodiplosis resinicoloides* (Williams) (*Cecidomyia*),[1] is brownish gray with the abdomen yellowish brown or red. The eggs are slender, bright orange, and 0.6 mm. long. The larvæ are also bright orange and 10 mm. long. The pupæ are orange red and 5 mm. in length. The larvæ inhabit the resinous exudations of the Monterey pine in California, and are apparently not injurious to the trees.

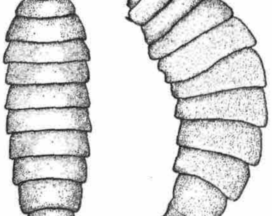

FIG. 440.—Larvæ of the box leaf midge, *Monarthropalpus buxi* Lab.

The box leaf midge, *Monarthropalpus buxi* Laboulbene,[1] (Figs. 439, B; 440), has been imported on ornamental box into various parts of the United States from Europe. The adults are yellowish or reddish orange, 2 to 2.5 mm. long, with 14-segmented antennæ. The eggs are transparent white, oval, 0.27 mm. long, and are laid

[1] F. X. Williams, *Ent. News*, 20, 1909, p. 1. Orig. desc. Anatomy of Larva. *Ann. Ent. Soc. Am.*, 3, 1910, p. 45.

[2] H. S. Smith, *Mthly. Bul.*, Cal. Hort. Com., 4, 1915, pp. 220, 341.

E. P. Felt, *Jour. Econ. Ent.*, 3, 1910, p. 342. 34th *Rept. State Ent. N. Y.* 1918, p. 236. Complete.

on the young leaves. The larvæ are pale yellow to orange, 3 mm. long, and live between the two epidermal layers of the leaves causing circular or irregular blotch-galls which are at first pale and later become brown. Pupation occurs in the leaf-galls, the adults emerging through a round hole leaving the pupal skin standing out with only the posterior end remaining in the hole. Although the insect is somewhat of a pest to various species of box in Europe, it has not been serious wherever found in California, but might have proved to be so if steps were not taken to eliminate the infestations. Defoliation or fumigation with hydrocyanic acid gas during the winter gives satisfactory control.

There are a number of beneficial species, the larvæ of which are predaceous on injurious mites, red spiders, aphis, scale insects, and so forth. *Mycodiplosis acarivora* Felt and *Arthrocnodax occidentalis* Felt [1] (Fig. 441) have small whitish or yellowish larvæ up to 2.5 mm. in length, which feed extensively on orchard mites or red spiders particularly on *Tetranychus bimaculatus* Harvey, *T. 6-maculatus* Riley, *T. telarius*

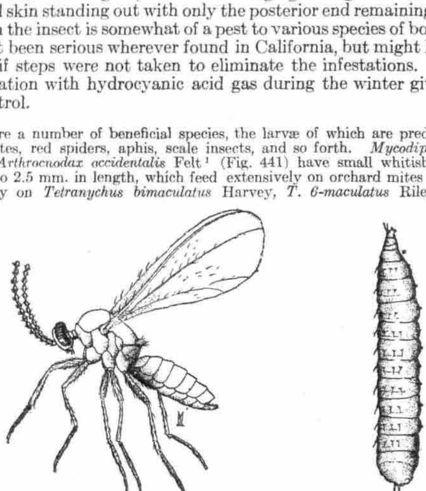

FIG. 441.—The red spider midge, *Arthrocnodax occidentalis* Felt. Adult and larva. (After Quayle.)

(Linn.), and *Paratetranychus pilosus* C. & F. in California and other Western States. *Aphidoletes meridionalis* Felt [2] has minute, elliptical, oval, orange-yellow eggs 0.31 mm. long, which are laid singly or in clusters up to 12 in number. The larvæ are pale pinkish to orange and 3 mm. long when mature. Pupation occurs in a thin silk cocoon on the plants. The adults are pale brown with pinkish abdomen and 1 to 1.5 mm. in length. They are nocturnal in habits. The eggs, larvæ, and pupæ are to be found among the colonies of many species of aphis upon which the larvæ feed. The list of aphis includes nearly all of the common economic forms belonging to at least ten different genera. The species occurs in the middle Western States and in Colorado, Oregon, and California in the west. *Coccidomyia erii* Felt feeds on the artemisia scale, *Amonostherium lichtensioides* (Ckll.), and *Dicrodiplosis californica* Felt, on the solanum mealybug, *Phenacoccus solani* Ferris, in Southern California. *Itonida hopkinsi* Felt (*Cecidomyia*) has been taken from the burrows of barkbeetles on pine in California.

BIBIONIDÆ. March Flies.

These are small to moderately large, long-legged, often hairy black or dull reddish flies, with short stout antennæ of 9 to 12 segments. They

[1] H. J. Quayle, Bul. 234, Cal. Agr. Exp. Sta. 1912, p. 514.
[2] J. J. Davis, *Jour. Agr. Research*, 6, No. 23, 1916, p. 883.

often appear in great numbers on blossoming fruit trees and other plants in the spring of the year and attract a good deal of attention. The larvæ are dark colored, tough, and with well developed heads. They live in and feed on decaying vegetable matter, manure, or on the roots of grasses, grains, vegetables, and other plants. The family *Scatopsidæ* has been separated from this family by A. L. Melander (Bul. 130, Wash. Agr. Exp. Sta. 1916). **The blossom fly,** *Bibio nervosus* Loew, is a small black and reddish hairy species with a conspicuous black spot near the middle of the costal margin of the wing. It is very common in the spring and early summer in California and Oregon and feeds in great numbers on the nectar in the blossoms of fruit trees, and may be a factor in pollination. It is thought that possibly the larvæ feed on the roots of grasses, clover, alfalfa, vegetables, weeds, and so on. *B. hirtus* Loew (Fig. 442) also occurs in Oregon and California, but is less common. Cole and Lovett report the larvæ as injurious to turnips in Oregon.[1] *B. albipennis* Say was reared from larvæ taken in great numbers in the soil at Salinas, California. It ranges throughout the west.

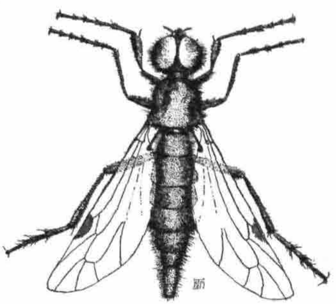

FIG. 442.—The hairy march fly, *Bibio hirtus* Loew. (After Woodworth.)

SIMULIIDÆ.[2] Buffalo Gnats, Black Flies.

This family consists of small, robust, humped black gnats with short legs and broad wings which are pestiferous bloodsuckers of domesticated animals and human beings. The eggs are laid in running water in which the small larvæ live anchored to stones or other objects by means of an anal sucker, breathing through three anal gills. The food consisting of minute aquatic animals and algæ is directed into the mouth by a pair of bush-like appendages situated on the head. Threads are spun in the water along which the larvæ move, and also for the attachment of the cocoon in which pupation occurs. The pupæ breathe by means of two bunches of long filaments. The adults are suspected of carrying diseases in some countries, but our western species appear to be only specialized tormentors.

Prosimulium fulvum (Coquillett) (*Simulium*) is reported in Alaska, British Columbia, Montana, Colorado, Oregon, New Mexico, and undoubtedly occurs generally through-

[1] List of Oregon *Diptera. Proc. Cal. Acad. Sci.* (4), 11, 1921, p. 225.

[2] D. W. Coquillett, *Simuliidæ of U. S.* Bul. 10. n. s. Div. Ent. U. S. Dept. Agr. 1898, p. 66.

J. R. Malloch, "Am. Black Flies or Buffalo Gnats." *Tech. Ser.* No. 26, Bur. Ent. U. S. Dept. Agr. 1914.

A. W. Jobbins-Pomeroy, "Notes on Five N. A. Buffalo Gnats of the Genus *Simulium*." Bul. 329, Bur. Ent. *Prof. Paper*, U. S. Dept. Agr. 1916.

out the west. **The Adirondack black fly,** *P. hirtipes* (Fries.), is European. It occurs in the New England States, and also in Idaho, Oregon, and Arizona. It is at times very troublesome to fishermen in the spring. *Parasimulium furcatum* Malloch is reported from Humboldt County, California, and *P. mutatum* Malloch from Alaska, British Columbia, and Washington. *Simulium bivittatum* Malloch is common along the willow flats of the Columbia River, Oregon, and bites bathers after sundown.[1] It also occurs in Washington, Colorado, and New Mexico. **The turkey gnat,** *S. meridionale* Riley (*S. occidentale* Townsend), is grayish or brownish black, 2 mm. long, and is often a great plague to man and domestic animals in the spring months in New Mexico.[2] It also occurs in the Southern and Eastern States, and is often a pest to nesting turkeys. *S. notatum* Adams is 1 to 1.5 mm. long and ocherous yellow. It has been reported as present in great swarms on horses in New Mexico.[3] *S. vittatum* Zetterstedt is the most widely distributed species. It is dark gray or velvety black, 2 to 3 mm. long, and is recorded throughout North America and in Alaska, Oregon, California, and Colorado in the west. It has been taken on domesticated animals but does not appear to be as pestiferous as some other species.

Brachycera (Division)

KEY TO FAMILIES [4]

1. Empodium pulvilliform, nearly or quite as large as the pulvilli, so that 3 rounded pads or scales appear under the tarsal claws 2
   Empodium either absent or filiform, with or without surface hairs, so that there are only 2 distinct pads or scales under the tarsal claws 8

2. Third antennal joint distinctly annulated or the antennæ consisting of more than 3 distinct joints 3
   Antennæ consisting of 3 joints, the third not annulated 6

3. Costal vein discontinued at or close to the apex of wing; antennæ long or short; palpi 2 jointed; tibiæ without spurs; discal cell present. Large or small pilose flies. (Soldier Flies.) . . . . **Stratiomyiidæ** [5] p. 553
   Costal vein continued round apex of wing, sometimes encircling the whole posterior margin 4

4. Squamæ very large, third joint of antennæ 4 to 8 annulated and without style or arista; eyes large, holoptic in male; proboscis rigid. Large, robust blood-sucking flies. (Horseflies, Gadflies, Breezeflies, Clegs.) . . . . **Tabanidæ** p. 554
   Squamæ small, sometimes vestigial 5

5. Robust species, with spinose scutellum; marginal vein encircling wing; third antennal joint elongated; adults variable brownish or testaceous in color . . . . **Cœnomyiidæ**
   Slender species, with unspined scutellum; marginal vein ceasing before reaching anal angle of wing; face flat or produced . . . . **Xylophagidæ**

6. Squamæ very large, inflated; head small; thorax globose; abdomen short and robust; proboscis often very long. Small or large flies. (Small-headed Flies.) **Cyrtidæ** p. 558
   Squamæ very small 7

7. Costa continued round posterior margin of wing; antennæ short with or without terminal or dorsal arista; legs stout, femora and tibiæ without bristles, tibiæ with spurs. (Snipe Flies.) . . . . **Leptidæ** p. 557
   Costa discontinued at apex of wing; head as wide as thorax; arista 3-jointed and terminal; tibiæ without spurs; posterior veins parallel with hind margin of wing. Usually hairy . . . . **Nemestrinidæ**

[1] F. R. Cole and A. L. Lovett, *Proc. Cal. Acad. Aci.* (4), 11, 1921, p. 227.
[2] C. H. T. Townsend, *Psyche*, 6, 1891, p. 106.
[3] T. D. A. Cockerell, *Ent. News*, 8, 1897, pp. 100, 172. Wrongly determined as *S. ochraceum* Walker.
[4] Adapted from J. R. Malloch, *Bul. Ill. State Lab. Nat. Hist.*, 12, 1917, p. 312.
[5] The *Acanthomeridæ* are considered synonymous with this family by Malloch.

8. Anal cell much longer than second basal, closed at or close to wing margin, or open; third vein usually furcate.......... 9
   Anal cell absent, or if present, shorter than second basal, or but little longer, and closed some distance from wing margin; if the apex of this cell is long and pointed, the third vein is not forked.......... 14

9. Vertex depressed, seen from in front the upper inner angles of eyes are considerably above the level of the frons; eyes always separated.......... 10
   Vertex not depressed, at least on a level with upper inner angles of eyes; eyes of male often contiguous.......... 11

10. Fourth vein curved forward apically, ending at or before tip of wing; antennæ 4-jointed, with clubbed style; proboscis fleshy, palpi vestigial. Large elongated predaceous flies without bristles on the body, large hind legs and black with red and yellow markings.......... **Mydaidæ**
    Fourth vein not curved forward; face bearded; proboscis stiff and horny, palpi usually prominent. Large naked or bristly predaceous flies. (Robber Flies, Assassin Flies).......... **Asilidæ** p. 559

11. Posterior cross vein present, *i. e.*, second basal cell with an obtuse apex formed by a cross vein; 5 posterior cells present.......... 12
    Posterior cross vein absent, *i. e.*, second basal cell with an acute apex; rarely 5 cells present, if present, the fifth cell is due to the bisection of the third by a cross vein.......... 13

12. Fourth vein curved forward and ending before the apex of wing; antennæ with very short terminal style; palpi 1 or 2 jointed, broadened at tip. (Flower-loving Flies).......... **Apioceridæ**
    Fourth vein not appreciably curved forward, ending behind apex of wing; palpi 2-jointed, not broadened at tip; antennæ with terminal style; proboscis fleshy, never elongated; eyes of male holoptic or nearly so. (Stiletto Flies.) **Therevidæ** p. 562

13. Fourth vein curved forward, ending at or before apex of wing; proboscis retracted, fleshy; antennæ without apical style; eyes of male usually holoptic. Usually small black bare flies. (Window Flies.).......... **Scenopinidæ**
    Fourth vein ending behind apex of wing; proboscis slender, usually much exserted; antennæ usually without a style; eyes of male usually holoptic, those of female rarely so; body stout and pilose, rarely slender and naked. Large and small often parasitic flies. (Beeflies.).......... **Bombyliidæ** p. 560

14. Discal cell usually separated from the second basal, always at least one distinct basal cell; squamæ small; abdomen of male usually with 7 segments exclusive of the hypopygium; black, brownish or yellowish species usually with chitinized proboscis, and with or without dorsal or terminal arista (Dance Flies.) **Empididæ** p. 562
    Discal cell not separated from second basal, the basal cells small and indistinct; squamæ moderately large, usually with conspicuous fringe; abdomen of male usually with 5 or 6 segments in addition to the hypopygium; metallic greenish or bluish species, usually with fleshy proboscis and with dorsal or terminal arista. (Long-legged Flies).......... **Dolichopodidæ** p. 562

STRATIOMYIIDÆ.[1] Soldier Flies.

The adults are brightly colored, medium-sized to fairly large flies, active on bright days and visiting flowers and leaves near wet places. The eggs of some species at least are elongated and laid in masses on leaves or plants wherever the larvæ live. The larvæ are elongated and somewhat

[1] C. W. Johnson, "Rev. of *Stratiomyia* and *Odontomyia* of N. A." *Trans. Am. Ent. Soc.*, 22, 1895, p. 227.
A. L. Melander, "Notes on N. A. *Stratiomyidæ*." *Can. Ent.*, 36, 1904, p. 14. (Family name spelled both ways.)

cylindrical or flattened, 12 segmented exclusive of the head, the antennæ distinct, the posterior spiracles fringed with long plumose hairs or devoid of fringe. The epidermis is often hard and the segments are plate-like. They are aquatic, feeding on algæ, decaying vegetable matter or *Crustacea;* or terrestrial acting as scavengers in nests of bees and wasps or in those of rodents. They also feed on manure, decaying vegetable matter, sap, carrion, and act as predators on insect larvæ in such matter. Pupation occurs in the larval skin. There are many western species, with little known concerning their life histories. *Stratiomyia maculosa* Loew (Fig. 443) is a black and yellow fly 14 mm. long, common in California, Oregon, Washington, Nevada, Utah, and Idaho. The larvæ are aquatic and feed on decaying

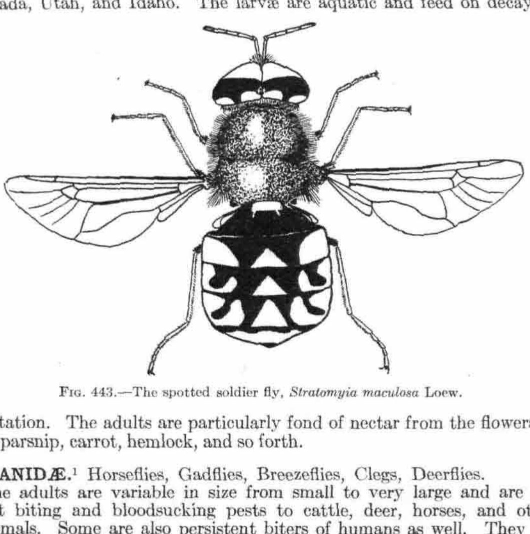

FIG. 443.—The spotted soldier fly, *Stratomyia maculosa* Loew.

vegetation. The adults are particularly fond of nectar from the flowers of wild parsnip, carrot, hemlock, and so forth.

TABANIDÆ.[1] Horseflies, Gadflies, Breezeflies, Clegs, Deerflies.

The adults are variable in size from small to very large and are the worst biting and bloodsucking pests to cattle, deer, horses, and other mammals. Some are also persistent biters of humans as well. They are most abundant during the hot summer and fall weather and are diurnal in habits. Some species are carriers or transmitters of serious animal and human diseases, particularly in the tropical regions, and *Chrysops discalis* Will. conveys a disease known as tularæmia from jackrabbits and

[1] J. S. Hine, "*Tabanidæ* of Ohio." Spec. Paper, Ohio State Acad. Sci. No. 5, 1903. *Habits and Life Histories of Some Horseflies of the Family Tabanidæ. Tech. Ser.*, 12, pt. 2, Bur. Ent. U. S. Dept. Agr. 1906. *Horseflies of Louisiana.* Bul. 93, La. Agr. Exp. Sta. 1907.

W. Marchand, "Early Stages of *Tabanidæ*." *Mon. Rockefeller Inst. for Med. Research*, No. 13, 1920.

W. B. Herms, *Med. & Vet. Entomology.* Macmillan, 1923, p. 192.

ground squirrels to man in Utah.[1] The slender elongated eggs are usually laid in compact masses stuck together with a cohesive secretion. They are attached to the leaves of aquatic and other plants, particularly cat-tail, and arrowhead, growing in or near water and are occasionally found on the leaves of fruit trees and ornamentals. The larvæ are large, round, and pointed at both ends, the commoner forms being white or marked with

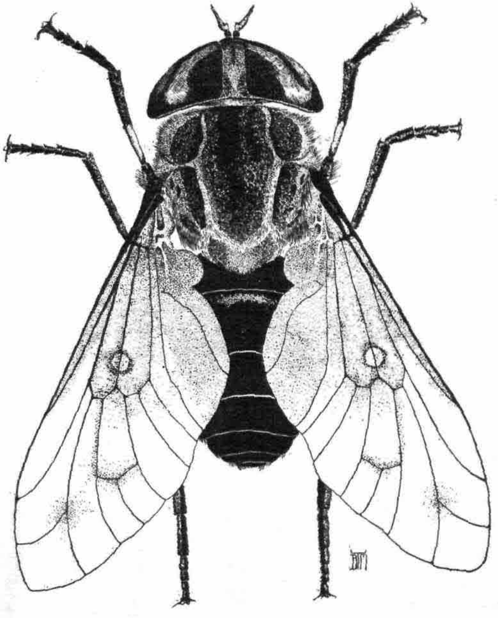

FIG. 444.—The western horsefly, *Tabanus punctifer* O. S. (After Woodworth.)

black. They are aquatic or semi-aquatic, living in the mud at the bottoms of ponds, ditches, and marshes, or in mud alone. They are supposed to be predaceous on snails, small animals, the larvæ of crane flies, and other insects living in such an environment.

There are two common genera, *Chrysops* and *Tabanus*. The larvæ of the former have the apical antennal joint much longer, while in the latter it is no longer than

[1] E. Francis, *Pub. Health Repts.* 36, No. 3, p. 1731, July 1921.

the preceding joint. The adults of *Chrysops* lack apical spurs on the hind tibiæ, which are present in *Tabanus*. The adults of the latter are separated from other genera in

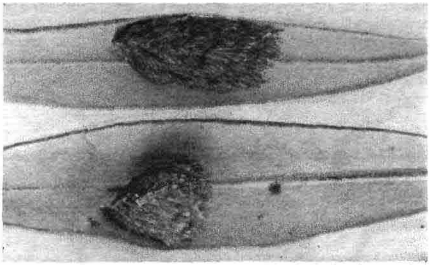

FIG. 445.—Eggs of the western horsefly, *Tabanus punctifer* O. S., in characteristic masses on the undersides of olive leaves. These eggs are usually laid on trees or plants overhanging water or in the immediate vicinity.

having the 5-segmented third antennal joint and the absence of hairs on the hind tibiæ. *Chrysops noctifer* Osten Sacken is one of the most common western species. The adults are small, 9 mm. long, shiny black, with two large basal orange spots and heavily clouded wings. They appear in April and May and seriously bite horses and cattle on the shoulders and flanks. The species is known in New Mexico, California, Nevada, Oregon, and British Columbia. *C. proclivis* O. S. is similar in appearance, size and habits to the preceding species, differing it having the second basal cell of the wing hyaline rather than clouded. It occurs in Arizona, California, Oregon, and British Columbia. *C. pachycera* Williston is 8 mm. long, with gray thorax lined black, and yellow abdomen with large median basal and many smaller apical black spots. The wings are infuscated to the tips, thus separating it from all the other species here enumerated. It occurs from Lower California into Oregon. *C. surdus* O. S. is marked much like the preceding fly but the black is more pronounced and the wings are clear at the tips. It is also considerably smaller in size. It occurs in California, Nevada, Oregon, and Washington, often at high altitudes. *C. fugax* Fabr. and *C. excitans* Walker are arctic forms ranging from Alaska southward, the former into Idaho, Montana, and Colorado; the latter, into Washington and Oregon. **The golden gadfly,** *Silvius gigantulus* Loew, is 8–10 mm. long and readily distinguished by the hyaline wings, dull greenish pilose thorax, and bright golden

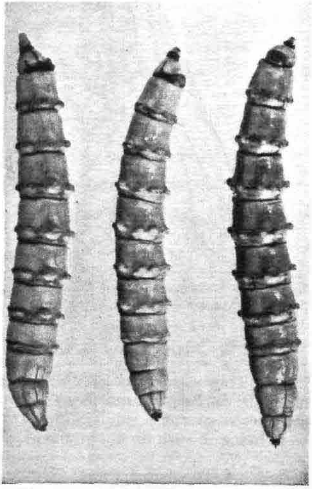

FIG. 446.—Larvæ of the western horsefly, *Tabanus punctifer* O. S.

abdomen. It commonly bites stock on the neck. The range includes New Mexico, Colorado, Nevada, California, Oregon, Idaho, and British Columbia.

There are a great many western species of *Tabanus*. The best known and largest is **the western horsefly**, *T. punctifer* O. S. (Figs. 444–446), is 25 mm. long, with whitish or golden pile on the thorax, and usually a small dark spot near the tips of the wings. It is very troublesome to horses and occurs in Mexico, New Mexico, Colorado, Utah, California, Nevada, Oregon, Washington, and Idaho. *T. ægrotus* O. S. is brownish black, the wings clear, the third antennal joint very broad at the base, and is 19–20 mm. long. It is the next largest western species, occurring in British Columbia, Washington, and Oregon. *T. affinis* Kirby is also a large species, with thin orange palpi, which bites cattle and horses chiefly on the face and shoulders in July in the northwest. It is an arctic species ranging across Canada and from Alaska through British Columbia into Colorado. *T. captonis* Marten, *T. phænops* O. S. (Fig. 447), and *T. sonomensis* O. S. are very similar, in color dark gray or blackish with much of the abdomen fulvous,

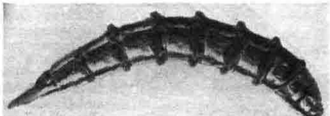

FIG. 447.—Larva of *Tabanus phænops* O. S. (Photo by S. B. Doten.)

of about the same size, 18–20 mm. long, and bite cattle and horses. The first occurs in British Columbia, Washington, Oregon, California, and Colorado; the second, in Oregon, California, and Nevada; and the third ranges from Alaska to Lower California and New Mexico. *T. hæmorphorus* Marten is also similar, 16–18 mm. long, and often the commonest species in British Columbia,[1] but also occurs south, ranging into Oregon and California. *T. atrobasis* McDonnough is separated by the entirely black first abdominal segment. It occurs in British Columbia and Oregon. *T. californicus* Marten is 17 mm. long and has the first four abdominal segments fulvous. It ranges from British Columbia into California. *T. insuetus* O. S. is small, 10 mm. long, with only the sides of the first four abdominal segments fulvous. It is a serious pest, biting horses and cattle chiefly on the abdomen. It ranges from Alaska to California and Nevada.

LEPTIDÆ.[2] Snipe Flies (Fig. 448).

The adults are robust flies with short antennæ and long stout legs. The larvæ are round in terrestrial, and flattened in aquatic forms, the head partially protruding, maxillary palpi well developed, the mandibles very long and vertical. The terrestrial forms have small spiracles, which the aquatic forms bear two rounded protrusive blood gills on the apical segment below the long terminal filaments. The adults of the aquatic genus, *Atherix*, are gregarious and often appear in countless numbers to lay their eggs in masses on the branches of willows or other trees overhanging streams, afterwards dying and remaining attached to the mass. Others add to the eggs until a large mass of eggs and several thousands of dead flies result. The young, upon hatching, drop into the water for development. In Oregon and Northern California the Indians, according to J. M. Aldrich,[3]

[1] J. C. McDunnough, *Can. Ent.*, 53, 1921, p. 141.

[2] D. W. Coquillett, "Syn. of the Dipterous Genus *Symphoromyia*." *Jour. N. Y. Ent. Soc.*, 2, 1894, p. 53.

J. M. Aldrich, "The Dipterous Genus *Symphoromyia* in N. A." *Proc. U. S. Nat. Mus.*, 49, 1915, p. 113.

Rhagionidæ replaces *Leptidæ* in Comstock's new work.

[3] *Ent. News*, 23, 1912, p. 159.

at one time collected the flies and eggs for food. The larvæ of the terrestrial forms are found in rotten wood, leaves, or other decaying vegetation where they are predaceous on insects and other small animals. They are in turn subject to attacks of parasitic nematodes. The adults of several species of *Symphoromyia* are bloodsuckers and inflict painful bites on humans.

Among the many western species the following have been recorded as severe biters. *S. atripes* Bigot is black with reddish legs, 5.3 to 8 mm. long, occurring throughout the west and known in Alaska, British Columbia, Washington, Oregon, California, Idaho, Montana, Utah, and Colorado. *S. hirta* Johnson is robust, black with yellow markings, and from 6 to 7.5 mm. long. It ranges in Idaho, Montana, Utah, Colorado, and New Mexico. *S. kincaidi* Aldrich is opaque, velvety black in the male, black with cinereous head and thorax in the female, and 5.5 to 6 mm. long. It is a bad biter and extends from British Columbia through Washington into California. *S. pachyceras* Williston is black with parts of the legs, proboscis, and the stems of the halteres yellow, and is 6 to 7 mm. long. It is a vicious biter and is known in Washington, Oregon, California, Montana, and Arizona.

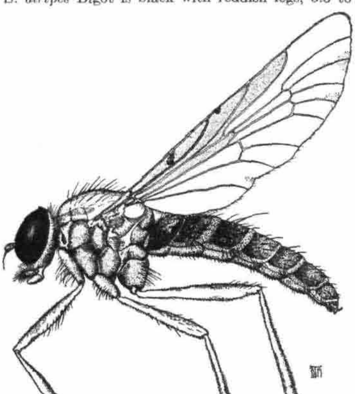

FIG. 448.—The snipe fly, *Cyrtopogon plausor* O. S. This species is known to occur in New Mexico, Colorado, Utah, and Idaho and probably has a much wider range.

CYRTIDÆ.[1] Small-headed Flies.

These are small flies with robust thorax and abdomen, and a very small, almost globular head located down near the front legs. The compound eyes occupy most of the head. They are rather rare and are most often taken on dead brush or trees. The first stage larvæ are campodea-like in that they have numerous spiny plates and two long apical bristles which are used in moving actively about in search of prey which consists chiefly of spiders and their eggs. When the larva enters the host the form changes rapidly into the characteristic sluggish parasitic maggot with indistinct segmentation and without apical bristles. The pupæ are distinguished by the greatly enlarged thorax which is longer than the short stout abdomen, and by the entire lack of body bristles.

[1] F. R. Cole, "The Dipterous Family *Cyrtidæ* in N. A." *Trans. Am. Ent. Soc.*, **45**, **1919**, p. 1.

J. H. Comstock considers *Cyrtidæ* a synonym of *Acroceridæ*.

There are a number of western species, the life histories of all of which are unknown. *Pterodontia misella* Osten Sacken is 5 mm. long, black, clothed with yellow pile, with the posterior half and venter pale, and the legs black and brown. It occurs in California and Oregon. *Eulonchus sapphirinus* O. S. is 9 to 11 mm. long, metallic blue or purple with green reflections, clothed with dense, erect, whitish or yellow pile, the legs straw yellow, the proboscis black and short or slightly longer than the abdomen. It ranges in California and Oregon. *E. smaragdinus* Gerstæcker is 8 to 12 mm. long, bright metallic emerald green or dull blue with whitish or golden pile, yellow legs, and curved proboscis much longer than the abdomen. It is quite common throughout California. *E. tristris* Loew like the preceding species, is variable in color from metallic green to very dark blue and purplish, with short yellow pile, legs black and brown with yellow markings, and proboscis black and just reaching beyond the tip of the abdomen. It is fairly common in Idaho, Oregon, and California.

ASILIDÆ.[1] Robber Flies, Assassin Flies (Fig. 449).

These are large to very large powerful flies usually with robust or slender hairy bodies and strong legs. The males have a prominent hypopygium and the females a pointed ovipositor. The majority are of a gray color but many are bright yellow and black. They are predaceous in habits and feed upon small and large insects which are readily taken on the wing and which are killed by inserting the sharp proboscis through the thin membrane of the thorax and extracting the body fluids. The larvæ are cylindrical or subcylindrical with distinct segmentation, the thoracic segments with 2 long hairs on each side of venter and with a variable apical segment. They inhabit the ground or decaying wood and are predaceous on other insect larvæ. The members of the family, as a whole, are considered beneficial, but the adults of some species destroy great numbers of honeybees. There are many western species, but little is known regarding their habits.

Adults of the genus *Dasyllis* are large, robust, hairy black species with white, yellow or orange markings, and somewhat resemble bumblebees. They are abundant about dead trees and decaying stumps and logs. The larvæ are opaque white, cylindrical, longitudinally striate with large heavily chitinized and dark heads. They somewhat resemble certain beetle larvæ.[2] *Dasyllis astur* (O. S.) (*Laphria*) is 14 to 20 mm. long, black, with the head, thorax, tibiæ, and the area before the tip of the abdomen beset with yellow hair. It is common in California, Oregon, and Washington. *D. californica* Banks is 18 mm. long, black, with yellow hair on the dorsum of thorax and tip of abdomen. The flies were taken by the writer in considerable numbers resting on logs about the shores of Lake Tahoe, California, and in Nevada. The species is also common in Oregon according to Cole and Lovett. *D. sackeni* Banks is 15 to 17 mm. long, black, with yellow hair on the head, thorax, and the penultimate abdominal segment. It is common in the San Francisco Bay region, California, and also occurs in Oregon. *Laphria vultur* O. S. is a large black species 19 mm. long, slightly more slender than the preceding one, and covered with bright orange hair. It occurs in the Coast Range and Sierra and Cascade Mountains of California, Oregon, and Washington. *Nicocles dives* (Loew) is 13 mm. long, rather slender throughout, black with brown legs, and

[1] S. W. Williston, "N. A. *Asilidæ*." *Trans. Am. Ent. Soc.*, I, 11, 1884, p. 1; II, 12, 1885, p. 53.
D. W. Coquillett, *Can. Ent.*, 25, 1893. *Syn. of Anisopogon*, p. 20. *Syn. of Blacodes*, p. 33. *Syn. of Mallophora and Nicocles*, p. 118.
E. A. Back, "Subfamilies *Leptogastrinæ* and *Dasypogoninæ*." *Trans. Am. Ent. Soc.*, 35, 1909, p. 137.
J. S. Hine, "Robber flies of the Genus *Asilus*." *Ann. Ent. Soc. Am.*, 2, 1909, p. 136. "Genera *Promachus* and *Proctacanthus*." *Ann. Ent. Soc. Am.*, 4, 1911, p. 153.
Chas. Schæffer, "New *Asilidæ*." *Jour. N. Y. Ent. Soc.*, 24, 1916, p. 65.
N. Banks, "Syn. Genus *Dasyllis*." *Bul. Brooklyn Ent. Soc.*, 12, 1917, p. 52.
[2] Chas. T. Greene, *Proc. Ent. Soc. Wash.*, 19, 1917, p. 149.

the wings clouded beyond the middle. The tips of the abdomen of the males are silvery. According to Cole and Lovett,[1] "they have the usual habits of the genus, perching on the tips of dead branches or tall grass stems. From these watch towers they flash out on some unsuspecting little wayfarer whose fate has been written. The silvery tips of the abdomen of the males glitter in the sunlight and are visible some distance away. Aphis, among other small insects, are a part of their food." The range includes Oregon and California.

The adults of the genus *Asilus* are the typical gray and well known robber flies with long slender bodies and cylindrical ovipositor with a terminal circlet of spines. The larvæ are predaceous, live in dry ground, and somewhat resemble grubs of beetles. *Asilus occidentalis* Hine (Fig. 449) is a typical form. The adults are dark gray, often with yellowish pile on the thorax. The tips of the femora and bases of the tibiæ are often brownish red. The hind ventral margin of the eighth abdominal segment has a dense cluster of long hairs. The length of the body varies from 14 to 18 mm. The species is common in California, Nevada, Oregon, Washington, and British Columbia.

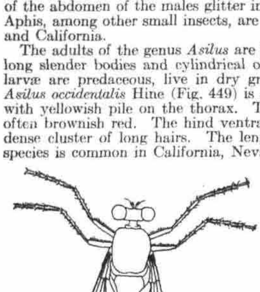

FIG. 449.—The western robber fly, *Asilus occidentalis* Hine. (After Woodworth.)

A. arizonensis Williston is one of the largest species of the genus measuring from 16 to 19 mm. The color is dull black with the hind margin of each abdominal segment yellowish gray, and the legs reddish. It is reported only from Arizona. *A. tenebrosus* Williston is about the same size, but brownish gray in color with narrow white margins on the apices of the abdominal segments. The wings have dark markings and the male genitalia are unusually wide. It occurs in Colorado, New Mexico, and Arizona.

Members of the genus *Erax* are similar to the preceding genus but may be distinguished by the laterally compressed ovipositor without the terminal circlet of spines. The adults may be likened to hawks in their manner of preying upon other insects. The larvæ live in the soil and feed on grubs and other insect larvæ. *Erax barbatus* Fabr. is 13 to 20 mm. long, black with white or yellow pile, and two rows of black spots on the abdomen. It is the most widely distributed species, ranging from Washington to Lower California and eastwardly to New England. *E. californicus* Schæffer is probably the largest species varying from 24 to 28 mm. in length. The color is black clothed with white pile. It occurs in California, Nevada, Oregon, and Washington. *E. bicaudatus* Hine is also a large species, 24 mm. long, and dark gray with white hairs. It occurs in Colorado. *E. jubatus* Williston is a large, black, robust species 18 to 23 mm. long, occurring in New Mexico, Colorado, and Arizona. *E. subcupreus* Schæffer is gray and black, 15 to 20 mm. long, living in Montana, Colorado, New Mexico, Arizona, and Nevada. *E. subpilosus* Schæffer is 22 mm. long and black with whitish hairs. The presence of pure white bristles on the legs is a distinctive characteristic. It is known in New Mexico, Utah, Nevada, and California. *E. zonatus* Hine is 16 mm. long and yellowish gray with four black bands around the abdomen. The female has a long black ovipositor. It ranges in New Mexico, Arizona, and Southern California.

BOMBYLIIDÆ.[2] Beeflies.

The larvæ resemble those of the *Asilidæ*, but have much smaller heads, crescent forms and a great reduction in the size of the hairs on the thorax

[1] List of *Diptera* of Oregon, *Proc. Cal. Acad. Sci.* (4), 11, 1921, p. 258.
E. T. Cresson, Jr., *Ent. News*, 26, 1915, p. 200.

[2] D. W. Coquillett, "Notes and Descriptions of *Bombylidæ*." *Can. Ent.*, 24, 1892. p. 123. "Notes and Desc. of N. A. *Bombylidæ*." *Trans. Am. Ent. Soc.*, 21, p. 89, 1894. "Mon. of Genus *Anthrax* of Am. North of Mexico." *Trans. Am. Ent. Soc.*, 14, 1887, p. 159. "Rev. of Species of *Anthrax* from Am. North of Mexico." *Trans. Am. Ent. Soc.*, 19, p. 168, 1892. Rev. of Bombylid Genus *Aphœbantus*. *West Am. Scientist*, 7, pp. 245–264, 1891.
F. R. Cole, "Notes on Osten Sacken's Group *Pœcilanthrax*. *Jour. N. Y. Ent. Soc.*,

and tip of the abdomen. They have variable habits, being inquilinous in nests of bees; predaceous on larvæ of certain beetle and grasshopper eggs; and parasitic on bees, wasps, hymenopterous parasites, tachina flies, beetle larvæ, and so forth. They have a complex metamorphosis or hypermetamorphosis. The adults are small to fairly large, robust, densely pilose, active flies which frequent flowers and act much like miniature humming birds. The wings are frequently clouded and the rostrum slender and greatly elongated. Little is known regarding the life histories of these most interesting flies and the family offers splendid opportunities for research work.

The larvæ of the large genus *Anthrax*[1] are usually parasitic on certain Hymenoptera and caterpillars and in some species are known to live as long as four years. The adults are usually black with yellowish or reddish markings. *Anthrax alpha* O. S., is a large black and brown species 11–14 mm. long, with orange markings on the sides of the base of the abdomen, and covered with orange and gray pile. The wings are very large and are clouded brown with hyaline spots, giving a marbled effect. It occurs in the higher mountains of California, Nevada, and Wyoming. *A. californicus* Cole is grayish black with blue tinge, has a round red spot on the lateral margins of the second and third abdominal segments, and clouded wings. It occurs in California, Nevada, and New Mexico. *A. edwardsi* Coq. is 6–10 mm. long, black and yellowish, and is known from British Columbia to California. *A. halcyon* Say is 13 mm. long, black with pale fulvous hair and brown wings, with a hyaline spot near the middle and another at the tip. It ranges from the middle States west into Colorado, New Mexico, Southern California, and Mexico. *A. edititia* Say is 12 mm. long and shiny black covered with dense orange-yellow pile. The bases of the wings are clouded brown. The larvæ are parasitic on the bee, *Anthophora montana* Cresson, in Arizona and California, and are known to live four years.[2] Adults have also been taken in Mexico and Oregon. *Anthrax molitor* Loew, is 7–17 mm. long and black with pale yellowish white pile. It has been reared from the chrysalis of a cutworm in California,[3] and also occurs in Arizona and Colorado. *A. signatipennis* Cole is 10 to 13 mm. long, has a gray-black thorax and red or yellow abdomen with first segment all black, black dorsal line, and orange venter. It occurs in Montana, Wyoming, Nevada, and California. *A. willistoni* Coq. has all the abdominal segments except the first with short white and yellow pile, and some have all the margins, except the first segment, reddish. It occurs in Wyoming, Colorado, New Mexico, and California. *Bombylius major* Linn. (Fig. 450) is 7–12 mm. long, densely covered with whitish, yellowish, or brown pile, often with black pile on the thorax and two lateral spots on the abdomen, and the anterior half of the wings dark brown or almost black. The rostrum is black and nearly as long as the body. It ranges throughout the United States and is common in British Columbia, Oregon, and Cali-

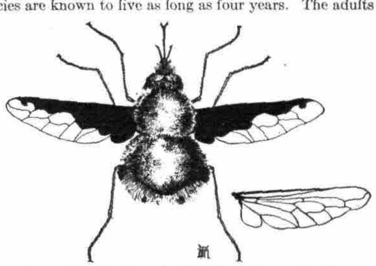

FIG. 450.—The large beefly, *Bombylius major* Linn. (After Woodworth.)

25, p. 67, 1917. "Notes on Cal. *Bombylidæ* with Desc. of New Species." *P. C. Jour. Ent. and Zoöl.*, 15, p. 21, 1923.

[1] *Villa* is given in preference to *Anthrax* by Cole and Lovett.

[2] A Davidson, *Ent. News*, 11, 1900, p. 511.

[3] *Insect Life*, 2, 1890, p. 353.

fornia. The larvæ are parasitic on the young of the bees, *Andrena*, *Halictus*, and *Colletes*. *Aphœbantus mus* (O. S.) (*Triodites*) is 8–9 mm. long, uniformly clothed with whitish gray pile, and with hyaline wings. The larvæ live in the egg pods of various species of grasshoppers including those of the lesser migratory locust and others in Utah, Arizona, California, and Mexico. *Spogostylum anale* Say is a shiny, velvety black fly with the basal two-thirds black and the tips hyaline. It is a southern species ranging west into Colorado, British Columbia, Washington, and Oregon. According to V. E. Shelford the larvæ are parasitic on the larvæ of the tiger beetle, *Cicindela scutellaris* Say var. *lecontei* Hald., in the middle west.

THEREVIDÆ.[1] Stiletto Flies.

This family consists of fairly large flies with slender tapering bodies, thus resembling robber flies, but with soft proboscis and slender legs. The larvæ are very long and slender and appear to have about 20 segments, but in reality have from 1 to 6. They inhabit the soil, decaying vegetable mold, rotten wood, and so forth, and are predaceous in habits, feeding on wireworms and other insect larvæ.

EMPIDIDÆ.[2] Dance Flies (Fig. 451).

These flies are usually very small and may be observed swarming about flowers and low shrubbery in the late afternoons and evenings of spring and summer. Their up-and-down motion in the air resembles dancing. Some species are as large as the beeflies. The spike-like proboscis is the most characteristic feature. They are predaceous on gnats, mosquitoes, and other small flies. The larvæ are aquatic, semi-aquatic or live in decaying vegetable matter and rotten wood, and are believed to be predators or scavengers. The family is a large one with many western species.

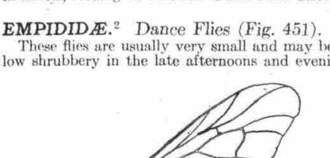

FIG. 451.—A dance fly belonging to the family *Empididæ*. (After Woodworth.)

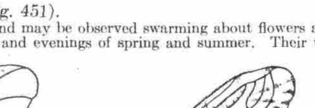

FIG. 452.—A fly belonging to the family *Mydaidæ*. (After Woodworth.)

DOLICHOPODIDÆ.[3] Long-legged Flies (Fig. 453).

This is a large family of rather small, delicate flies which are often metallic green or golden, and, less often, yellow or black in color. Many species occur in flowers and

[1] F. R. Cole, "Rev. of N. A. *Therevidæ*." *Proc. U. S. Nat. Mus.*, 62, p. 1, 1923.

[2] A. L. Melander, "Mon. N. A. *Empididæ*." *Trans. Am. Ent. Soc.*, 28, p. 195, 1902. "The Genus *Drapetis*." *Ann. Ent. Soc. Am.*, 11, p. 183, 1918.

D. W. Coquillett, "Revision of *Empididæ*." *Proc. U. S. Nat. Mus.*, 18, p. 389, 1896. "Genera of *Empididæ*." *Proc. Ent. Soc. Wash.*, 5, p. 245, 1903; 6, p. 51, 1904.

[3] J. M. Aldrich, "Contrib. to the Study of N. A. *Dolichopodidæ*." *Trans. Am. Ent. Soc.*, 30, p. 269, 1904.

practically all are predaceous upon small insects. The larvæ are aquatic or terrestrial. Some species occur in burrows of beetle larvæ under bark, some in the stems of plants, and a few occur among seaweed on the beach.

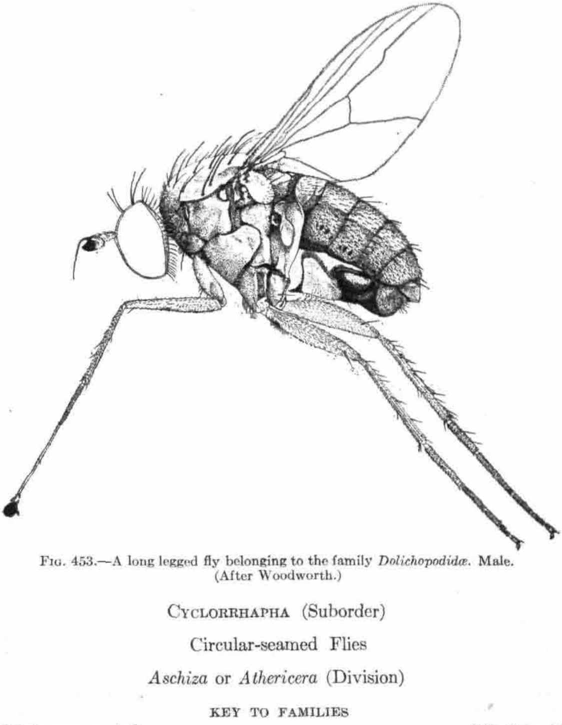

FIG. 453.—A long legged fly belonging to the family *Dolichopodidæ*. Male. (After Woodworth.)

CYCLORRHAPHA (Suborder)

Circular-seamed Flies

Aschiza or *Athericera* (Division)

KEY TO FAMILIES

1. Palpi one-segmented . . . . **Phoridæ** p. 564
   Palpi more than one-segmented 2

M. C. Van Duzee, "Notes and Descriptions of *Dolichopodidæ* from Alaska." *Proc. U. S. Nat. Mus.*, 63, p. 1, 1923.

M. C. Van Duzee, F. R. Cole and J. M. Aldrich, *The Dipterous Genus Dolichopus in North America*. Bul. 116, U. S. Nat. Mus., 1921, 304 pp., 16 pl.

J. M. Aldrich, "A New Genus of Fly with Mandible-like Labella." *Proc. Ent. Soc. Wash.*, vol. 24, 145–148, 1922.

2. Antennæ with terminal style or arista.. 3
   Antennæ with a dorsal arista. Head semi-globular and larger than thorax; ocelli present. Small flies. (Big-eyed Flies.)......................Pipunculidæ p. 565

3. Wings usually with a spurious longitudinal vein between the third and fourth longitudinal veins. Frons convex beneath antennæ. Small to large dark flies often marked with bright yellow. (Syrphus Flies, Flower Flies, Sweat Flies.) **Syrphidæ** p. 566
   Wings without spurious vein.. 4

4. First posterior cell wide open; ocelli present; males holoptic with enlarged hind tarsi. Small active flies. (Flat-footed Flies.)..................**Platypezidæ**
   First posterior cell closed or narrowed; frons with grooves or depression between the antennæ; proboscis long; genetalia conspicuous. Small flies resembling wasps. (Thick-headed Flies)...............................**Conopidæ** p. 574

PHORIDÆ.[1] *Humpbacked Flies.*

The adults are very small black or yellow flies with rounded humpback and low small heads. The wing venation is peculiar in that the heavy costal vein extends only to about the middle of the front margin of the wing and the other veins, except two close to the costa, are very much weaker. The antennæ are 3-jointed, the first joint small and the second almost enclosed in the large spherical or conical third, giving the appearance of being one- or two-jointed. The arista is 3-jointed and dorsal or apical. The flies are found on certain flowers and leaves, and often in houses. The larvæ mostly feed upon decayed vegetable or animal matter, but some are parasitic on ants, bees, beetles, snails, and so on, and a few are myrmecophilous. The latter are often apterous or nearly so. The western species are not well known.

Plastophora curriei Malloch is a small yellowish or brownish species less than 1 mm. long which is parasitic on the fire ant, *Solenopsis geminata* Fabr., in British Columbia. **The red-legged phorid,** *Aphiochæta rufipes* Meigen, is the commonest species of the genus occurring in Europe and America. It is small, 2.5 to 3 mm. long, black or dull brown with yellowish or brown legs. The abdomen has very long scale-like hairs on the lateral and posterior margins of the segments. The larvæ commonly feed on dead material and have been taken from nests of bees. Adults have been reared from decaying gladiolus and other bulbs and from apparently dry cured beet seed. The western range includes British Columbia, Oregon, Idaho, and California.

PLATYPEZIDÆ.[2] Flat-footed Flies.

The adults get the common name from the somewhat enlarged and flattened hind tarsi which are specially ornamented in some of the males, but in other respects most of the males are similar to the females. Three species of males have the ornamented kind. They are small, often appearing in swarms in the air or running on low shrubs, and are ordinarily overlooked by the amateur. The larvæ are small, flattened, cream-colored jointed maggots with segmented spiniferous processes on the sides of all the segments except the first, second, and last. They live in the fleshy portions of toadstools, mushrooms, shelf, and other fungi upon which they feed. Very little is known concerning the members of this family in the west. *Platypeza agarici* Willard and *P. polypori* Willard are black velvety flies, 2.5 to 3.5 mm. long, with cream-colored maggots which commonly infest mushrooms in the San Francisco Bay region, California.

[1] C. T. Brues, "Mon. N. A. *Phoridæ.*" *Trans. Am. Ent. Soc.*, 29, 1903, p. 331.
J. R. Malloch, "Insects of the Dipterous Family *Phoridæ* in U. S. Nat. Mus." *Proc. U. S. Nat. Mus.*, 43, p. 411, 1913.
This family is placed in the *Brachycera* by Williston and older authors.
[2] J. M. Aldrich, *Ent. News*, 17, p. 123, 1906.
Frankie Willard, *Psyche*, 21, p. 166, 1914.

PIPUNCULIDÆ[1] Big-eyed Flies.

The adults are small slender flies with large almost hemispherical heads due to the enormous size of the compound eyes. They are commonly taken on flowers, grasses, and small shrubbery. According to H. H. P. Severin the eggs are laid on young and adult leafhoppers and the somewhat

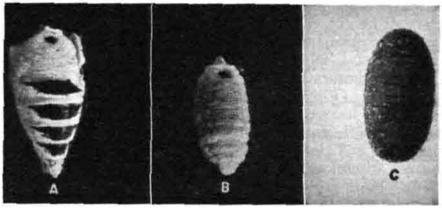

FIG. 454.—The big-eyed fly, *Pipunculus vagabundus* Knab. A, abdomen of *Eutettix tenellus* (Baker) containing larva; B, larva; C, pupa. (After Severin.)

pointed maggots make their way into the body of the host and usually locate in the abdomen. When full grown they rupture the dorsal integument between the thorax and abdomen leaving a large exit hole in the dead carcass. From the sugar beet leafhopper, *Eutettix tenellus* (Baker), in California, Severin reared two new species which were described by F. Knab[2] as *Pipunculus industrius* Knab and *P. vagabundus* Knab (Figs. 454, 455). Both species are about 3.5 mm. long and black in color. They may be separated by the gray pruinose on the body and the presence of a brown stigma in the wing of the first and the absence of these characters in the latter. The former has been taken in the Salinas Valley and the latter in the same locality, but also further north and in the southern part of the State. Cole and Lovett[3] report the eastern species, *P. atlanticus* Hough, *P. confraternus* Banks, *P. proximus* Cresson, and *P. similis* Hough, in Oregon, which indicates a wider western distribution. Studies in this important economic family are greatly needed.

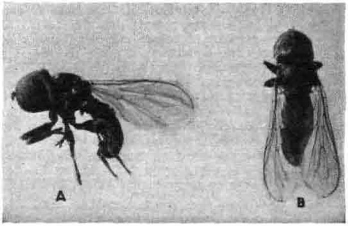

FIG. 455.—The big-eyed fly, *Pipunculus vagabundus* Knab. A, female; B, male. (After Severin.)

[1] G. de N. Hough, "The *Pipunculidæ* of U. S." *Proc. Bost. Soc. Nat. Hist.*, 29, 1899, p. 77.

E. T. Cresson, Jr., "Studies in N. A. *Pipunculidæ*." *Trans. Am. Ent. Soc.*, 36, 1910, p. 267.

[2] *Proc. Biol. Soc. Wash.*, 28, 1915, pp. 83, 84.

[3] F. R. Cole and A. L. Lovett, *Proc. Cal. Acad. Sci.* (4), 11, No. 15, 1921, pp. 272–273.

SYRPHIDÆ.[1] Syrphid Flies, Flower Flies, Sweat Flies, Hover Flies, Drone Flies.

The adults are small to large flies of dull colors but often gaudily striped with yellow. They frequent flowers and all kinds of plants and are common everywhere throughout the summer season. In flight they are remarkably quick and are often seen poised in mid air and darting from place to place with ease, particularly in the sunny spots in the woods. There is considerable mimicry of bright yellow and black wasps and hairy bees. Many of the flower visitors probably aid in pollination. The larvæ are much more variable in form and habits than are the adults. As a rule they are slug like with pointed anterior end, but some few are like small molluscs and live in ants' nests. Others are scavengers in the nests of bumblebees and wasps. A number have a long tail-like anal breathing tube enabling them to live in liquid filth and decaying organic material and are known as rat-tail maggots. A large group are predaceous on aphis and scale insects and are, therefore, very beneficial. A few forms, however, attack bulbs, woody plants and trees, and are injurious. The family is a large one and abundantly represented in the west. Because of the many interesting species the comments must be brief and somewhat tabular in form.

The larvæ of *Microdon* are mollusc-like in form and have often been mistaken for scale insects. They live in ants' nests and but little is known concerning them. *Microdon tristis* Loew is the best known American species. The adults are 6–10 mm. long, black or metallic green with white and pale yellow pile. The variety *cothurnatus* Bigot is the western form, in which the tibiæ and the tarsi are entirely orange or yellowish red. The larvæ occur in the nests of subspecies and varieties of *Camponotus maculatus* Fabr. in Colorado, Washington, and Oregon. *M. marmoratus* Bigot is 9 mm. long, dark brown and densely covered with fawn pile. It is endemic in California and Oregon. *M. piperi* Knab[2] is a beautiful dark blue species 9 mm. long with white pile. The larvæ are 11 mm. long, pale bluish green with the median ridge and margins brown. The surface consists of coarse net-like reticulations. The species occurs in the nests of *Camponotus maculatus vicinus* Mayr in Oregon and California.

Heringia californica (Davidson) (*Pipiza*) is 9 mm. long, metallic black clothed with white and black pile. The larvæ have been reared by W. M. Davidson from the poplar stem gall aphis, *Pemphigus populicaulis* Fitch, in California.

Paragus tibialis (Fallén) is 3–5 mm. long, shining dark green or black with the tip of the abdomen red or yellow. It is a very widely distributed species occurring in Europe and North America. In the west it occurs in British Columbia, Washington, Oregon, California, and Colorado, and the brown or gray larvæ feed on the pea aphis, thistle aphis, and other aphis. *P. bicolor* (Fabr.) is somewhat larger, 4 to 6 mm. long and of the same general color excepting that the abdomen is wholly red. The larvæ

[1] S. W. Williston, *Syn. N. A. Syrphidæ.* Bul. 31, U. S. Nat. Mus. 1886.
R. C. Osburn, "*Syrphidæ* of British Columbia." *Can. Ent.*, 36, 1904, p. 213; 44, 1908, p. 1.
C. L. Metcalf, "*Syrphidæ* of Ohio." *Ohio State Univ. Bul.*, 17, No. 31, 1913. "*Syrphidæ* of Maine." *Maine Agr. Exp. Sta. Bul.* 253, 1916; Bul. 263, 1917. "Genintalia of Male *Syriphidæ*, etc. *Ann. Ent. Soc. Am.*, 14, 1921, p. 169.
R. C. Shannon, "Notes on New Genera of *Syrphidæ* and Desc. of N. Spp." *Proc. Ent. Soc. Wash.*, 18, 1916, p. 101.
W. M. Davidson, "Economic *Syrphidæ* in California." *Jour. Econ. Ent.*, 9, 1916, p. 454.
C. R. Jones, "New *Syrphidæ* of Colorado." *Ann. Ent. Soc. Am.*, 10, 1917, p. 219. *Syrphidæ of Colorado.* Bul. 269, Colo. Agr. Exp. Sta. 1922.
C. H. Curran, "Rev. of *Syrphus* of *Ribesii* Group." *Can. Ent.*, 53, 1921, p. 152. "New Species of *Syrphidæ*." *Can. Ent.*, 53, 1921, p. 171. "Rev. of *Pipiza* Group of *Syrphidæ*." *Proc. Cal. Acad. Sci.* (4), 11, 1921, p. 345.

[2] F. R. Cole, *P. C. Jour., Ent. and Zoöl.*, 15, 1923, p. 20.

are rough, spiny, and brownish, and feed on root aphis including *Fullawaya saliciradicis* Essig. The species is known in British Columbia, Washington, Oregon, California, Montana, Wyoming, Colorado, and New Mexico.

The hemlock bark maggot, *Chilosia alaskensis* Hunter,[1] is 8 mm. long in the adult stage and shining deep blue with short pile. The larvæ are white with black head and with a tail as long as the body. They live between the inner bark and the wood, having first gained access through holes made by small barkbeetles, and cause "black check" in western hemlock in Alaska, British Columbia, Washington, and Oregon. **The lowland fir bark maggot,** *C. hoodiana* (Bigot), has brown adults and similar maggots which work under the bark of white or lowland fir in British Columbia, Washington, and Oregon. The species is also reported from New Mexico. Many other western species are known, without life history data.

The lemur syrphid, *Baccha lemur* Osten Sacken (Fig. 456), is dull gray or bronzy black with a slender wasp-like body 9–11 mm. long and hyaline wings with a black spot on the front margin near the middle. The larvæ feed on various coccids including mealybugs and the artemisia scale. The species is indigenous to New Mexico, Colorado, Wyoming, Arizona, Nevada, and California. **The four-spotted aphis fly,** *Baccha clavata* (Fabr.) (*B. babista* Walker), is about the same size but green and reddish brown with the wings partially brownish. The larvæ are dull green with a red dorsal line, and feed on various aphis. The distribution includes South and North America and adjacent islands. In the west the species is known in Colorado, New Mexico, Arizona, and California.

FIG. 456.—The lemur syrphid, *Baccha lemur* O. S.

The bird syrphid, *Eupeodes volucris* O. S., is 7–10 mm. long, shining green and black with yellow spots on the second and fifth abdominal segments. It is one of the commonest syrphids in the west and the larvæ prey extensively on aphis. It is known in Washington, Oregon, California, Nevada, Utah, Colorado, Arizona, and New Mexico.

Members of the large genus *Syrphus* are abundant in the west on flowers and plants. The eggs are elongated and white with roughened surface, and are laid singly on plants infested with aphis. The larvæ are truncate posteriorly, pointed anteriorly, and blindly loop about in search of prey which when found is raised in the air until sucked dry. Pupation occurs on the plants or under leaves and rubbish on the ground. **The American syrphid,** *Syrphus americanus* Wiedemann (Fig. 457), is 9–10 mm. long and metallic greenish in color with yellow cross bands on the abdomen, the first of which is continuous and the second and third, though interrupted in the middle, do not quite reach the margins. The cheeks are black and there is a brown stripe on the face. It is a very common and beneficial species and the green or yellowish larvæ are general feeders on many kinds of aphis. It ranges throughout the country and occurs in Montana, Colorado, New Mexico, California, Nevada, Oregon, Washington, and British Columbia. The fungus, *Empusa muscæ* Cohn, kills many of the

[1] H. E. Burke, *Circ.* 61, Bur. Ent. U. S. Dept. Agr. 1905.

adults. **The arcuate syrphid,** *Syrphus arcuatus* (Fallén), is 9–12 mm. long, metallic green or black, with the three principal yellow bands inter-

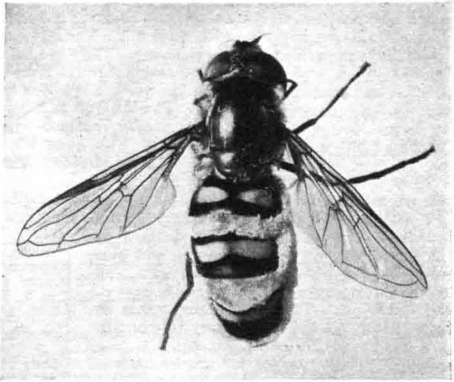

FIG. 457.—The American syrphid, *Syrphus americanus* Wied., killed by the parasitic fungus, *Empusa muscæ* Cohn, the white spores of which appear between the abdominal segments and along the sides.

rupted, those on the third and fourth segments arcuated. The larvæ are yellowish, brownish, or purplish, and are effectual destroyers of all kinds of aphis. The adults appear early in the spring reaching the maximum in numbers in March and April, usually in advance of other species. In some States this syrphid is more abundant at altitudes of 2,000 feet and over. It has a wide range in Europe and America and is indigenous in Alaska, Washington, Oregon, California, Nevada, Idaho, Wyoming, Colorado, Arizona, and New Mexico.

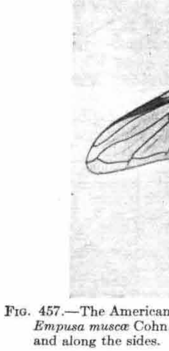

FIG. 458.—The egg of the large syrphid, *Lasiophthicus pyrastri* (Linn.), among the cast skins of aphis.

The western syrphid, *Syrphus opinator* O. S., is distinguished by the yellow face and cheeks, bare eyes, and the unbroken yellow cross band on the second and third abdominal segments which does not reach the lateral margins, although the first band does extend to the margins. The length is 9–11 mm. This is a truly western species which is common and abundant and one of the most beneficial, the larvæ being general feeders on aphis. It occurs in all the States west of the Rocky Mountains and north into British Columbia.

The European syrphid, *Syrphus ribesi* (Linn.), is of the usual type, 7–12 mm. long, the first yellow band interrupted in the middle, the second en-

tire, the third entire with a median incision. The eyes are bare, and the venter of the abdomen is as a rule alternately marked with yellow and black bands. The larvæ are general feeders on aphis. It is a European species widely distributed in North America and occurs throughout the Pacific Coast States from Alaska through California and into New Mexico in the south.

The cruel syrphid, *Syrphus torvus* O. S., is marked much like the former, but is readily separated from it by the hairy eyes. The larvæ are aphis feeders. It is widely distributed throughout Europe and North America and ranges in the same western areas as the preceding species.

The oblique syrphid, *Allograpta obliqua* (Say), is a small species 6–7 mm. long, with narrow yellow cross bands at the base and oblique and longitudinal lines at the tip of the abdomen. The larvæ are general and effective destroyers of aphis. It is a widespread and common species throughout North and South America and abundant in Washington, Oregon, California, and Colorado. *A. fracta* O. S. is much the same as the preceding species in appearance, but is smaller and readily separated by the black stripe on the face and the entirely black first abdominal segment. The larvæ have the same habits. It is endemic in Oregon, California, and Mexico.

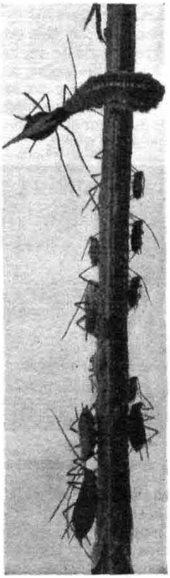

FIG. 459.—Larva of the large syrphid, *Lasiophthicus pyrastri* (Linn.), feeding on the alfalfa aphis, *Illinoia creeli* (Davis). (Photo by S. B. Doten.)

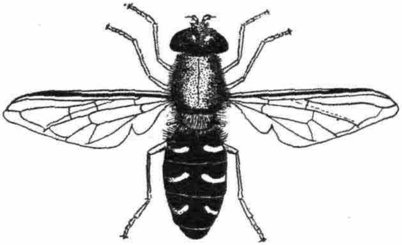

FIG. 460.—Adult of the large syrphid, *Lasiophthicus pyrastri* (Linn.).

The large syrphid, *Lasiophthicus pyrastri* (Linn.) (*Syrphus*)[1] (Figs. 458–460), is the most abundant and beneficial as well as the best known western species. It is larger than similar species being 11 to 14 mm. long, with yellow face, black proboscis, reddish brown eyes and antennæ, dark metallic blue thorax covered with soft pile, and velvety or shining black abdomen with three sets of broken yellow bands. The eggs are elongate,

[1] E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 327.

white, rough, 0.08 mm. long; the larvæ vary from green to brown with whitish or yellow longitudinal stripes and are 8 to 15 mm. in length; the pupæ are dark grayish brown and 7–9 mm. long. The adults are very common about flowers and on trees and plants of all kinds wherever aphis occur. They appear in March and continue throughout the year. The larvæ are general feeders on all kinds of aphis. Pupation occurs on the plants or on the ground under leaves. The distribution includes every Western State including British Columbia. The fungus, *Empusa muscæ* Cohn, kills great numbers of the adults, the dead bodies of which are found clinging to grasses and shrubbery.

The geminate syrphid, *Mesogramma geminata* (Say) (*Scæva*, *Mesograpta*), is 5–6 mm. long, shining black with median cinereous line on dorsum of the thorax, and yellow markings on the abdomen. The thickened arcuate hind femora and dilated tips of the tibiæ of the male separate it from other species. W. M. Davidson [1] has recorded the larvæ breeding in the trunks and limbs of poplar in the Imperial Valley, California. The range is throughout North America and in the west, Washington, Oregon, and California.

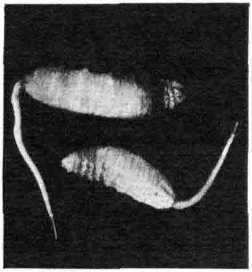

FIG. 461.—Rat-tail maggots of the drone fly, *Eristalis tenax* (Linn.).

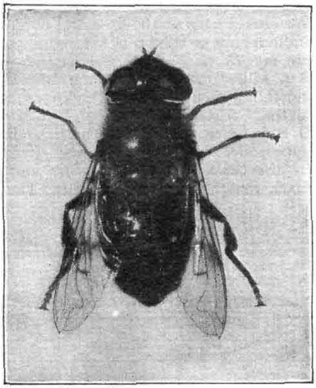

FIG. 462.—The drone fly, *Eristalis tenax* (Linn.).

The slender syrphids, *Sphærophoria melanosa* Williston and *S. sulphuripes* (Thomson), are metallic dark species with yellow abdominal markings. The former is green or bluish and has the coxæ and bases of the femora of the male black, while the latter is black with yellow coxæ. The larvæ and pupæ are green. The maggots feed on aphis and those of *S. sulphuripes* (Thomson) also feed on thrips.[2] The distribution of both species includes Oregon, California, Arizona, and New Mexico, and the latter also extends into Washington, British Columbia, and Alaska.

[1] *Can. Ent.*, 51, 1919, p. 235.
[2] W. M. Davidson, *Jour. Econ. Ent.*, 9, 1916, p. 454.

The cactus syrphid, *Copestylum marginatum* (Say) (*Volucella*),[1] is a short stout species 9–11 mm. long, shining black with gray pile, and with either the dorsum of the abdomen entirely yellow or with yellow markings. The arista is densely plumose. The larvæ are white with dark brown markings, 20 mm. long, with the tail 1 mm. long. They live as scavengers in decaying joints of opuntia cactus and other decaying vegetation.

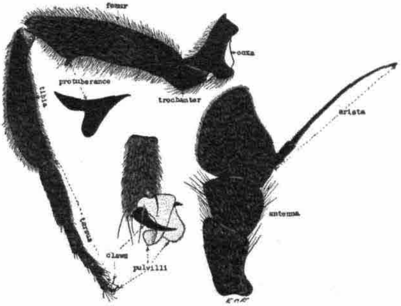

FIG. 463.—Some anatomical parts of the bulb fly, *Merodon equestris* (Fabr.). Hind leg and antenna.

The species ranges from South America through Mexico into Texas, New Mexico, Arizona, California, and north to Montana. The staphylinid beetle, *Maseochara valida* (Lec.), destroys the puparia.

The Mexican cactus fly, *Volucella esuriens* (Fabr.) (*V. mexicana* Macq.), is a large, conspicuous, metallic bluish or purplish black fly 16–19 mm. long, the bases of the wings brownish black. This fly appears early in the spring and is often exceedingly

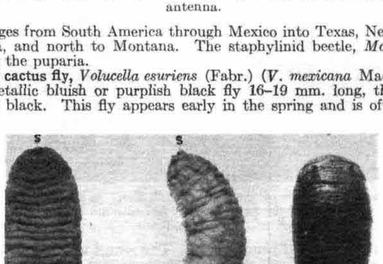

FIG. 464.—Larvæ and pupa of the bulb fly, *Merodon equestris* (Fabr.). M, mouth hooks; S, posterior spiracle.

numerous on the flowers of ceanothus, greasewood, and other plants. The larvæ are scavengers in decaying cactus. The species ranges from South America, through Mexico into Texas, New Mexico, Arizona, California, and the Southern States. The larvæ of *V. avida* O. S. feed on the common opuntia cactus and the giant cactus in Arizona and California, and those of *V. fasciata* Macquart, on opuntia cactus in Mexico, Arizona, Texas, Colorado, and California in the west, and in other parts of the United States.

[1] Bul. 113, Bur. Ent. U. S. Dept. Agr. 1912, p. 37.

Members of the large genus *Eristalis* are medium to large, more or less thickly pilose, usually brownish flies, many of which greatly resemble honeybees. In fact, since Aristotle promulgated the erroneous theory that honey bees could be generated from the dead carcass of an ox, the uninitiated are still unable to distinguish the common drone fly from the honeybee. These flies are flower visitors and aid in pollination. The larvæ are known as **rat-tail maggots** because of the long tail-like respiratory tube which permits the body to remain wholly under water or wet filth. The best known species is **the drone fly,** *Eristalis tenax* (Linn.) (Figs. 461, 462), which is about the same size and color as the common honeybee, 15 mm. long, and produces a similar humming noise when tightly held in the hands. The adults are especially abundant on composite flowers while the rat-tail maggots live in open privies, stagnating water, and similar unsanitary places. The species is cosmopolitan, having followed civilization to practically all places. It is abundant throughout the west.

The bulb fly, *Merodon equestris* (Fabr.) [1] (Figs. 428, 463–465), is a large, hairy black fly, marked with gray, yellow, or orange, 10–13 mm. long,

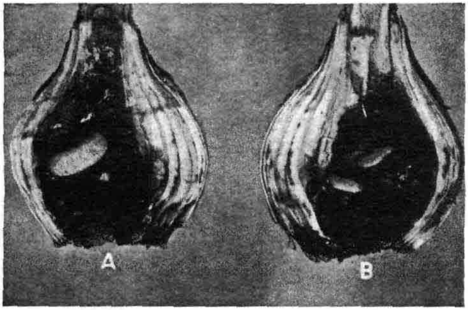

FIG. 465.—Narcissus bulbs showing the work of bulb flies. A, larva of the bulb fly, *Merodon equestris* (Fabr.); B, larvæ of the lesser bulb fly or onion fly, *Eumerus strigatus* (Fallén).

greatly resembling a small bumblebee. The small white eggs are laid on or near the crown of the host plants near the surface of the soil. The very large maggots are white, yellowish, or brown, robust, 12 to 15 mm. long, wrinkled, with a conspicuous but short respiratory tube at the posterior end. The large brown oval puparia have two little horn-like respiratory organs. Usually but a single maggot is found in a bulb, the centre of which is soon reduced to a thick brown excrementaceous mass. Narcissus bulbs are preferred, but amaryllis, hyacinth, eurycles, galtonia, habranthus, hippeastrum, lilies, tulips, and vallota are infested. It is a European species which has been introduced in bulbs to all parts of this country and has survived in certain favorable places. In the west it is recorded in British Columbia, Washington, and California. Infested bulbs can be detected by pressing to determine the solidity. The maggots are killed

[1] E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. 1915, p. 325.

by cutting into the centre with a sharp knife, or by vacuum fumigation, but carefully culling of the infested bulbs should always be practiced.

The lesser bulb or onion fly, *Eumerus strigatus* (Fallén) (Figs. 427, 465–467), is commonly associated in the west with the preceding species. The adults are much like the aphis feeding species in appearance, being small, from 4–6 mm. long, and black with yellowish abdominal bands. The larvæ are small, dirty white, or brownish, 8–12 mm. long, with quite a long brown respiratory tube and with a flat body projection on each side. They work on the inside of various lilaceous bulbs usually in company with the larvæ of the large fly, which has led some investigators to believe they are scavengers. In California it appears that this fly is mostly secondary on

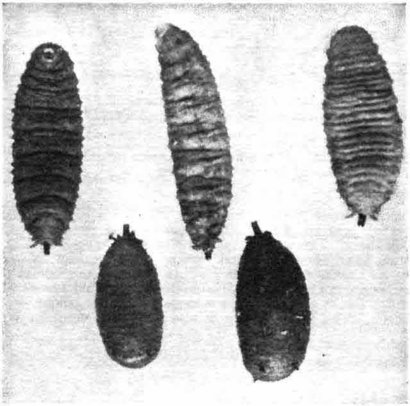

FIG. 466.—Larvæ and pupæ of the lesser bulb fly, *Eumerus strigatus* (Fallén).

decaying bulbs, iris rhizomes and other decaying plants, but in some states it is claimed to be a real pest to onions and bulbs. It is a European species reported to have two broods in England. In this country it is injurious to the bulbs of hyacinth, amaryllis, narcissus, onions, Spanish iris, shallots, and so forth. In the west it is quite common in parts of British Columbia,[1] Washington, Oregon, Colorado,[2] and California. According to D. B. Mackie the larvæ can be killed in the bulbs by vacuum fumigation, using 2 pounds of carbon disulfid to 100 cubic feet of air space, for 1 hour.

The sapwood maggots belonging to the genus *Xylota* live in the sapwood of living trees or in the decaying heartwood. *Xylota ejuncida* Say is 10 mm. long, shiny black with two pairs of yellow spots on the abdomen. It is probably the commonest species

[1] Arthur Gibson, *Can. Ent.*, 49, 1917, p. 190.
[2] F. R. Cole, *Ent. News*, 31, 1921, p. 32.

throughout the whole country and occurs in Washington, Oregon, California, Arizona, and Colorado in the west. The larvæ live in sapwood and decaying wood. *X. subfasciata* Loew is 8–9 mm. long and bronze green and black, with the second and third

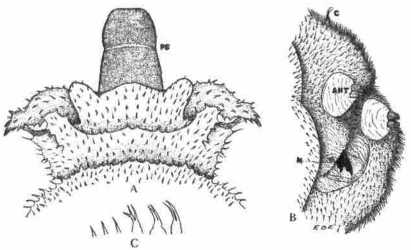

FIG. 467.—Some anatomical parts of the larva of the lesser bulb fly, *Eumerus strigatus* (Fallén). A, posterior end; B, anterior end; C, body spines; ANT, antenna; M, mouth hooks; Ps, posterior spiriacle.

abdominal segments luteous. It is a northern species reared from decayed heartwood of Douglas spruce by Cole and Lovett [1] in Oregon.

CONOPIDÆ.[2] Thick-headed Flies.

These are inconspicuous flower-visiting flies, the larvæ of which are parasitic on wild bees, wasps, and grasshopper eggs. The females strike the bees in flight as a means of ovipositing on them. There are a number of western species with little or nothing known concerning their life history and habits. *Physocephala affinis* Williston has been reared by A. Davidson [3] from the bee, *Anthidium emarginatum* (Say), in California. It also occurs in Oregon and Washington. Cole and Lovett [4] have observed *Dalmannia pacifica* Banks and *Oncomyia modesta* Williston, striking bees of the genus *Halictus* in Oregon. The latter species is also known to occur in Washington and Colorado.

SCHIZOPHORA (Division)

Calyptratæ (Group)

In this group the calyptra or squamæ are large, or if small, distinct; the thorax has a complete transverse suture; the first longitudinal vein is never very short and usually of considerable length; and the frons of the male narrowed or the eyes contiguous.

KEY TO FAMILIES [5]

1. Oral opening small, mouth parts small or rudimentary 2
   Oral opening and mouth parts normal 3

2. Fourth longitudinal vein (M_{1+2}) of fore wing extends in nearly a straight line towards the margin of the wing. (Horse Bot Flies.) .... **Gastrophilidæ** p. 575

[1] *Proc. Cal. Acad. Sci.* (4), 11, 1921, p. 289.

[2] N. Banks, "Syn. of *Zodion and Myopa* with notes on *Conopidæ*." *Ann. Ent. Soc. Am.*, 9, 1916, p. 191.

J. H. Comstock places this family in the *Acalyptratæ*.

[3] *Ent. News*, 6, 1895, p. 253.

[4] *Proc. Cal. Acad. Sci.* (4), 11, 1921, pp. 295–296.

[5] Also see Charles T. Green. "A Tentative Arrangement of the Muscoid Flies Based on the Puparia." *Proc. Ent. Soc. Wash.*, 27, pp. 157–163, 1925. (With chart.)

Fourth longitudinal vein (M_{1+2}) of fore wing is bent so that the first posterior cell (R_5) is much narrowed or closed at the margin of the wing. (Bot and Warble Flies.) .... **Œstridæ** p. 576

3. Meta-episternal sclerites (hypopleuræ) with a row of bristles; first posterior cell narrowed or closed 4
Meta-episternal sclerites without row of bristles; first posterior cell narrowed, closed, or open 7

4. Arista entirely bare or apical half bare, 3-jointed; abdomen with long bristles on basal middle dorsum *in addition to fine hairs. Variable-sized flies with noticeably* hairy bodies. Larvæ parasitic in other insects. (Tachina Flies.) .... **Tachinidæ** p. 578
Arista plumose or distinctly pubescent 5

5. Arista plumose halfway or slightly beyond, and distal portion bare; middle dorsum of abdomen rarely with stout bristles. Medium-sized to large grayish flies. Larvæ scavengers or parasitic on insects and other small animals. (Flesh Flies.) .... **Sarcophagidæ** p. 585
Arista bare or entirely plumose or pubescent 6

6. Middle dorsum of abdomen usually with stout hairs; arista two or three jointed; legs generally long and bristly .... **Dexiidæ**
Dorsum of abdomen with but few stout hairs at tip; legs normal. Larvæ breed in carrion, manure, and filth. (Bluebottle and Blow Flies.) ... **Calliphoridæ** p. 587

7. First posterior cell narrowed or closed; arista entirely plumose or pectinate. Small flies. Larvæ breed in manure and filth. (House Flies, etc.) **Muscidæ** p. 587
First posterior cell wide open; arista plumose, pubescent or bare. Small to medium-sized dull flies. Larvæ are scavengers, parasitic, root-infesting, or disseminators of diseases. (Root Maggots.) .... **Anthomyidæ** p. 590

GASTROPHILIDÆ.[1] Gadflies, Horse Bot Flies.

The horse bot or nit fly, *Gastrophilus intestinalis* De Geer (*G. equi* Clark) (Fig. 468), is the common stomach bot of the horse. The adult is 18 mm. long, brownish, and looks somewhat like a honey bee, but has a whitish face and often has three rows of blackish spots on the abdomen. These flies are slow of flight and are to be found about horses where they attach the minute, elongated, pale yellow nits or eggs to the hairs on the forelegs, hind legs, chest, stomach, and other parts of the body. They are supposed to require friction and moisture, as furnished by licking, to induce hatching which occurs in from 10–14 days. The small hairy larvæ are readily transferred by the tongue and lips to the mouth and pass to the stomach where they become attached by means of strong mouth hooks to the inner lining. In severe cases the walls may be entirely lined with bots, which when full grown are tough, oval, distinctly segmented spiny maggots, 15–18 mm. long. They remain in the stomach from summer through the winter and become mature in the spring when they lose their hold, pass to the ground, and pupate in the soil, emerging as adults in from 3–5 weeks. The species is European and has been distributed with horses throughout the world. In the west it is known in Montana, Wyoming, Idaho, Washing-

[1] C. H. T. Townsend, "Tables to Genera of *Œstridæ*." *Proc. Ent. Soc. Wash.*, 2, 1891, p. 94.
W. B. Herms, *Med. & Veter. Entomology*. Macmillan, 1923, p. 300.
S. Hadwen, *Parasitology* 7, p. 331, 1915.
The *Gastrophilidæ* and *Œstridæ* have in the past been considered in the one family *Œstridæ* by most writers.

ton, British Columbia, Oregon, and California, and probably occurs in other States as well. Internal remedies should be administered by a veterinarian. Eggs are destroyed by the careful use of kerosene or are removed by clipping. The flies do not lay eggs on stabled horses.

The nose bot fly, red-tailed bot, or lip bot fly, *Gastrophilus hæmorrhoidalis* (Linn.),[1] is the most important species in the genus wherever it is abundant. The adults are 15 mm. long and have the tip of the abdomen orange red. According to Parker the minute eggs are 1.35 mm. long and of two parts, an enlarged laterally flattened portion and a slender stalk 0.5 mm. long, which has spiral bands giving the appearance of a screw. They are attached to the hairs of the lips, more often on the lower lip than on the upper. The flies appear in May and remain until the middle of July. The horses become very much agitated when the flies strike and often violently rub their noses on any handy objects, but are unable to dislodge the eggs.

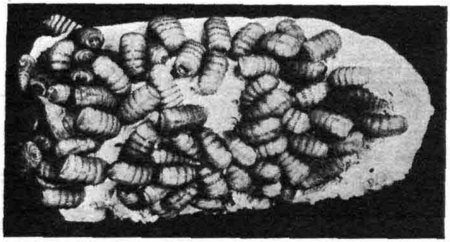

FIG. 468.—Bots or larvæ of the horse bot fly, *Gastrophilus intestinalis* De Geer, attached to a portion of the stomach wall of a horse.

The larvæ attach themselves in the stomach, duodenum, and rectum of the horse. It is a widely distributed European species and is known in the west in Washington, Oregon, California, Idaho, Montana, Colorado, and probably occurs in many other States.

The chin fly or throat bot fly, *Gastrophilus veterinus* Clark [*G. nasalis* (Linn.)], attaches the stalkless eggs which are 1.25 mm. long to the hairs of the intermaxillary space beneath the head. It is an introduced species and is reported on horses from Montana, Wyoming, Colorado, New Mexico, and Oregon in the west.

ŒSTRIDÆ.[2] Bot Flies, Warble Flies.

The sheep bot or sheep gadfly,[3] *Œstrus ovis* Linn., is hairy, 12 mm. long, dull yellow and most active in the hot sunshine of midsummer. The females thrust minute living maggots upon the nostrils of the sheep or goats

[1] R. R. Parker, *Jour. N. Y. Ent. Soc.*, 24, p. 253, 1916.
F. C. Bishopp, *Psyche*, 24, p. 182, 1917.

[2] S. Hadwen and A. E. Cameron, *Bul. Ent. Research*, 9, p. 93, 1918.

[3] This fly is also known as the false gadfly, and the maggots as grub-in-the-head, sheep head grub.
Farmers' Bul. 1150, U. S. Dept. Agr., p. 17, 1920.

which appear to sense danger and run when the flies attempt to larviposit. The maggots live in the nostrils, frontal sinuses and maxillary sinuses, and do not mature until the following spring or for about 10 months. They are then yellowish, 20–30 mm. long and 7 mm. wide. Their presence causes extreme annoyance and death. When mature they work out and pupate in the soil emerging as adults in from 6–8 weeks. The species is widely distributed throughout Europe and North America and is known in the west in Colorado, Oregon, and California. It ordinarily attacks sheep, but also infests goats in California as well as wild deer.[1] Some of the maggots may be squeezed out of the anterior opening of the nose.

The deer bot fly, *Cephenomia pratti* Hunter (Fig. 469), infests pouches of the throat of wild deer in California, New Mexico, Texas, and Mexico.

The ox bot, ox warble or heel fly, *Hypoderma lineata* De Villiers[2] (Fig. 470), is a large, robust, black and white hairy species, 13 mm. long, with a

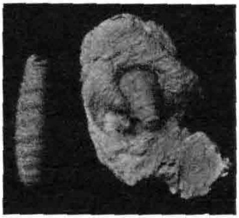

FIG. 469.—Larvæ of the deer bot fly, *Cephenomyia pratti* Hunter, from the throat-pouch of wild deer.

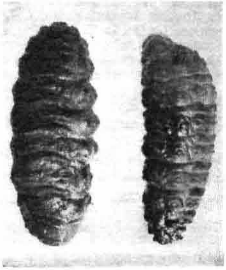

FIG. 470.—Larvæ of the ox bot, ox warble, or heel fly, *Hypoderma lineata* De Villiers.

tuft of whitish hairs on each side of the prothorax, the disc of the thorax almost bare but with longitudinal stripes, and the terminal hairs of the abdomen orange red. The small oval white eggs are 1 mm. long, attached to the hairs, usually in series on each hair, about the feet of the front legs, sides, belly, and roots of the tail, and hatch before or after being licked up and taken into the mouth. Many now believe that the larvæ enter the body from numerous places directly through the skin and that but few if any are taken into the mouth. The young maggots work their way throughout the body to just beneath the skin on the back where they cause tumors or swellings known as warbles. Here they mature and cause much annoyance to the host. A small hole is made for respiration and for the discharge of waste material and is used eventually as a means of escape to the soil when full grown, where pupation occurs. Besides the loss in

[1] W. D. Pierce, *Spec. Pub.* No. 22, Div. Anim. Ind. Cal. State Dept. Agr., p. 5, 1922.

[2] The common European *Hypoderma bovis* De Geer does not occur in the west.
C. Warburton, "The Warble Flies of Cattle." *Parasitology*, 14, 1922, p. 322.
E. W. Laake, "Distinguishing Characters of the Larval Stages of Ox Warbles, etc." *Jour. Agr. Reserach*, 21, No. 7, 1921, p. 439.

flesh and great reduction in the milk supply of dairy cows, the holes in the hides greatly reduce their value for leather. Control measures are difficult. It is possible for an experienced hand to squeeze out the warbles, but the pests should not be killed and allowed to remain in the warbles. Removal or destruction of the eggs is possible in carefully tended dairy cows, but not practical on ranges. R. A. Cooley [1] reports this species attacking horses in Montana. It ranges throughout Northern United States and Canada and is reported in the west in British Columbia, Washington, Oregon, California, Idaho, Montana, Wyoming, Utah, and Colorado by F. C. Bishopp.[2]

The rabbit grub, *Cuterebra* [3] *cuniculi* (Clark), is large and black, the dorsum of the thorax clothed with yellowish brown hair and the first abdominal segment with yellow hair. These flies look very much like bumblebees. The larvæ are large, black, and spiny, and form large tumors under the skin of domestic and wild rabbits throughout various parts of the country. The species has been reported in Colorado, Arizona, and California in the west. *C. leporivora* Coquillett infests cottontail rabbits in New Mexico, Wyoming, and California. *Bogeria princeps* Austen (*Cuterebra lepusculi* Townsend) attacks jackrabbits and cottontail rabbits in New Mexico, Colorado, Arizona, California, and Nevada. *Cuterebra tenebrosa* Coquillett has been reared from pack rats and grasshopper mice in Montana by R. R. Parker and R. W. Wells.[4] It also occurs in Colorado, Oregon, and California.

TACHINIDÆ.[5] Tachina Flies.

This is a large economic family of beneficial flies, the larvæ of which are parasitic on innumerable destructive pests. The good done in this way cannot be estimated as it is so obscure and ramifying, and we can only say that these flies play a considerable part as a natural check to plant-feeding insects.

Gymnosoma fuliginosa Desv. is 5–8 mm. long, yellowish and marked with black. It is recorded from *Chlorochroa sayi* Stål by J. M. Aldrich [6] and occurs in British Columbia, Washington, Idaho, Oregon, Arizona, and New Mexico, and elsewhere in the United States.

Trichopoda pennipes (Fabr.) is 7 to 12 mm. long with a yellowish abdomen and the lower calypteres wholly yellow. It has been reared from leaf-footed plant bugs and the squash bug, and ranges from Florida to Southern California. *T. plumipes* (Fabr.) is shining black with yellow fascia on the second, third, and fourth abdominal segments, and is 7 to 11 mm. long. It has been reared from the red-wing locust in middle California;

Myiophasia robusta Coq. is black and bronzy with gray pollinose on the abdomen. the length is 9 mm. It has been reared by Albert Koebele from the larva of *Sphenophorus robustus* Horn in Southern California.

[1] 18th *Rept. State Entom. Mont. Bul.* 139, Mont. Agr. Exp. Sta., 1921, p. 15.

[2] *Ann. Ent. Soc. Am.*, 8, 1915, p. 359.

[3] M. C. Hall, "*Cuterebra* Larva from Cats with a List of those Recorded on Other Hosts." *Jour. Am. Vet. Med. Assn.*, 1921, p. 3.

[4] *Jour. Parasitology*, 5, 1919, p. 100.

[5] D. W. Coquillett. "Revision of the *Tachinidæ*." *Tech. Ser.* 7, Div. Ent. U. S. Dept. Agr. 1897.

C. H. T. Townsend, "Synoptic Table of N. A. Genera of *Tachinidæ*." *Trans. Am. Ent. Soc.*, 19, 1892, p. 134. "A Record of Results from Rearings and Dissections of *Tachinidæ*." *Tech. Ser.* 12, pt. 6, Bur. Ent. U. S. Dept. Agr. 1908.

F. M. Van der Wulp, *Biologia Centr. Am. Diptera*, 2, 1903, p. 5.

J. M. Aldrich, "Results of Twenty-five Years' Collecting in the *Tachinidæ* with Notes." *Ann. Ent. Soc. Am.*, 8, 1914, p. 79.

J. M. Aldrich and R. T. Webber, "Genus *Phorocera* and Allied Genera." *Proc. U. S. Nat. Mus.*, 63, p. 1, 1924.

[6] *Ann. Ent. Soc. Am.*, 8, 1915, p. 81.

The eleodes parasite, *Eleodiphaga caffreyi* Walton,[1] the male of which is 9 mm. long and black with thin gray pollinose on the antennæ, has been reared from *Eleodes extricata* (Say) and *E. obsoleta* (Say) in Arizona and New Mexico. *Eleodiphaga pollinosa* Walton is also 9 mm. in length, with long white pollinose on the thorax, scutellum, and basal two-thirds of the abdomen. It has been reared from *Eleodes hispilabris* (Say) in New Mexico.

Admontia hylotomæ Coq. is 6–9 mm. long, black, with the thorax and last three abdominal segments gray pruinose. It has been reared from sawflies in the east and in the Sierras in California. *A. retiniæ* Coq. is 5 mm. long, black, with gray pollinose and with yellow palpi. It has been reared from chrysalids of a small pine moth (*Evetria* sp.), in the San Francisco Bay region, California.

Thryptocera flavipes Coq. is 4 mm. long, with gray pollinose without distinct vittæ on the thorax. It has been reared from mature caterpillars of *Phryganidia californica* Pack. in California,[2] and is recorded from Alaska and New Hampshire.

The diabrotica parasite, *Celatoria diabroticæ* Shimer (*C. crawi* Coq.), is 4–6 mm. long, black, with gray pruinose, and with yellow palpi. It has been reared from the adults of *Diabrotica soror* (Fab.), *D. duodecimpunctata* (Fabr.), *D. vittata* (Fabr.), and *D. trivittata* (Mann.), and occurs in Texas, California, and the east. *Celatoria spinosa* Coq. is 3.5 to 5 mm. long and has black palpi. It is recorded in the east and in California and Idaho.

Tachinophyto vanderwulpi (Townsend) (*Myothyria*) has been reared from the larval mines of *Monoxia consputa* (Leconte), in Utah by W. W. Jones. The fly is also recorded in California, Florida, and Porto Rico.

The codling moth tachinia, *Lixophaga variabilis* (Coq.) (*Hypostena*), is 4–9 mm. long, subopaque, with the third abdominal segment pollinose and the basal portion with yellowish pile. It has been reared from the larvæ of the codling moth, a pyralid moth, and a sawfly in Canada. J. F. Lamiman has reared it from the codling moth larvæ at Alviso, California. It also attacks the grape leaf folder.

Uramyia halisidotæ (Townsend) (*Uromacquartia*)[3] is 8–10 mm. long, black, with the base of the antennæ, palpi, and tip of the proboscis yellow. It has been reared from *Halisidota argentata* Packard in Oregon and is parasitic on *Malacosoma californica* (Packard) in California. It also occurs in the east.

Leskia gilensis (Townsend) has been reared from *Ægeria rutilans* (Hy. Edw.) in Oregon (Cole and Lovett), and also occurs in New Mexico.

Isoglossa hastata Coq. is 6 mm. long, black, the palpi and portions of the last three abdominal segments orange yellow. It has been reared from *Titanio belialis* Druce[4] in Colorado and also occurs in California.

Epigrymia floridensis Townsend has been reared from *Plodia* sp. in New Mexico by T. D. A. Cockerell. It ranges through the east.

Siphona plusiæ Coq. is 3 to 4.5 mm. long, grayish black with the sides of the first two abdominal segments partially or entirely yellow. It has been reared from caterpillars of *Autographa californica* (Speyer) by Coquillett and *Phryganidia californica* Pack. by W. Bloser[5] in California.

Plagiprospherysa parvipalpis Van der Wulp is 6–9 mm long, black, with the palpi, first two antennal joints, tip of the scutellum, and often the

[1] *Proc. Ent. Soc. Wash.* 19, 1917, p. 24.
[2] H. E. Burke and F. B. Herbert, *Farmers' Bul.* 1076, U. S. Dept. Agr. 1920, p. 10.
[3] J. M. Aldrich, *Ins. Insci. Menstr.*, 9, p. 83, 1921.
[4] H. G. Dyar, *Proc. U. S. Nat. Mus.*, 25, p. 397, 1903.
[5] *Ann. Ent. Soc. Am.*, 7, 1914, p. 301.

corners of the second and third abdominal segments yellow. It occurs in New Mexico, Colorado, Washington, and California, and has been reared from *Stenopelmatus pictus* Scudder at Palo Alto, California, by C. D. Duncan.[1]

Plagia americana Van der Wulp is 7–9 mm. long, shiny black, with dark vittæ on the thorax. It has been reared from larvæ and pupæ of *Autographa californica* (Speyer) in Washington by J. A. Hyslop. It also occurs in Oregon and elsewhere in North America.

Pachyophthalmus floridensis Townsend is 5 to 9 mm. long, the thorax and scutellum cinereous with three black vittæ over both, the abdomen shining black, the fourth segment partially or entirely yellow. The writer[2] has reared it from the cells of the mud-dauber, *Sceliphron servillei* (Lep.), in Southern California. The adults escape through the thick walls by moistening and scraping the mud away by means of the ptilinum. A. Davidson has reared it from probably the same host and D. W. Coquillett also records it from other wasps in Southern California.[3]

Senotainia trilineata (Van der Wulp) is 6 mm. long, cinereous, the antennæ and legs blackish, the thorax with three dark vittæ, and the second and third abdominal segments each with three dark spots. It occurs in Mexico, Texas, Colorado, California, Oregon, Washington, and elsewhere in North America. In Oregon it has been reared from the giant sand wasp, *Sphecius speciosus* (Drury), by Cole and Childs. *Pseudotractocera neomexicana* Townsend is 4–6.5 mm. long and dull silvery gray with four dark vittæ on the thorax. It was originally described from New Mexico. The writer has reared it from adults of *Serica serotina* Lec. taken at Sacramento, California.

Biomyia georgiæ Brauer and Berg. (*Pseudotractocera calosomæ* Coq.) is 7.5 mm. long, black, the first two antennal joints and palpi yellow. According to C. W. Collins and C. E. Hood[4] the eggs are glued singly or in patches on the exterior surface of the host and the larvæ enter the body immediately upon hatching. There are two generations annually. The hosts are the beneficial predacious ground beetles, *Calosoma peregrinator* Guér., in California and *C. calidum* Fabr., and other species of this genus, and *Carabus* spp. in the Eastern States.

Aphria ocypterata Townsend is 6–10 mm. long, black, the frontal vitta, usually the first two antennal joints, palpi, and sides of the abdomen yellowish. It has been reared from *Euxoa messoria* (Harris) by C. V. Piper in Washington. It also occurs in California, Colorado, and the Eastern States.

Bonneta comta (Fallén) (*Linnæmyia*) is 9–12 mm. long, the cheeks without black macrochætæ near the centres, and the frontal vittæ yellow. It has been reared from *Agrotis ypsilon* (Rott.) in California, from *Euxoa messoria* (Harris) in Washington, from *Lycophotia margaritosa* (Haw.) in Colorado, and from other *Noctuidæ* throughout the country. It also occurs in Europe and Mexico.

Hyphantrophaga hyphantriæ (Townsend) is 6–7 mm. long, silvery, cinereous, and black. It has been reared from *Hyphantria cunea* (Drury) by

[1] *Ent. News*, 34, 1923, p. 77.
[2] *P. C. Jour. Ent. and Zoöl.*, 14, 1922, p. 78.
[3] *Tech. Ser.* 7, Div. Ent. U. S. Dept. Agr. 1897, p. 18.
[4] *Jour. Agr. Research*, 18, p. 483, 1920.

D. W. Coquillett, from *Eucaterva variaria* Grote by C. H. T. Townsend in New Mexico, and from *Aglais milberti* (Godt.) by C. F. Baker in Colorado.

Nemorilla maculosa (Meigen) (*Tachina pyste* Walker, *Exorista pyste* Coq.) is 5–8 mm. in length, black with gray pollinose, the thorax with five black vittæ, the sides of the intermediate abdominal segments sometimes yellowish, and the tips of the fourth segment of the female sometimes reddish. It has been reared from *Archips argyrospila* Walker in New Mexico and Colorado (Gill); from *Hulstia undulatella* Clem. in California (Titus); and from other small moths in other parts of the United States.

Zenillia affinis (Fallén) is 5–9 mm. long, black with thin gray pollinose, the thorax faintly vittate, and the fourth abdominal segment polished black. It has been reared from arctian moths in Europe and North America. It is found at high altitudes in Colorado, Montana, Idaho, and Utah in the west. *Z. cæsar* (Aldrich) (*Exorista nigripalpis* Townsend) is mostly shining black with thin gray pollinose. It has been reared from *Harmologa fumiferana* (Clem.) in British Columbia (Tothill); *Archips argyrospila* Walker and *Loxostege sticticalis* (Linn.) in Colorado (Gill), and from the former in New Mexico (Gill) and Washington (Newcomer); and from other moths in various parts of the country.

Zenillia cheloniæ (Rondani) (*Exorista*) has been reared from *Malacosoma americana* (Fabr.) in Utah (Aldrich) and Arizona (Goffrey); from *Apantesis ornata* Pack. in British Columbia; *Malacosoma disstria* Hbn. and *Phragmatobia assimilans* Walker *franconica* Slosson in Canada by J. D. Tothill;[1] from *Archips argyrospila* Walker in Colorado and Arizona by J. B. Gill;[2] from *Turuptiana permaculata* Pack. in Colorado (Gillette) and *Arachnis picta* Pack. in California (Coquillett).

Zenillia confinis (Fallén) has been reared from *Plebeius melissa* (Edw.) in Colorado (Gillette); from *Brephidium exilis* Bdv. in New Mexico (Cockerell); and from other lycænids in the United States.

Zenillia blanda Osten Sacken has been reared from *Archips argyrospila* Walker in Colorado (Walton), and from *Vanessa cardui* (Linn.), *Alabama argillacea* (Hbn.), *Hypena humuli* Harris, *Thanaos brizo* Bdv. and Lec., *Loxostege similalis* Guenée, *Euclea delphinii* Bdv., *Acrobasis comptoniella* Hlst., and from other lepidopterous insects in different parts of the United States.

Zenillia eudyræ (Townsend) (*Exorista*) has been bred from *Estigmene acræa* (Drury) and many other moths in various parts of North America. It is reported from British Columbia in the west.

Zenillia futilis (O. S.) has been reared from *Malacosoma disstria* Hbn. and *Autographa californica* (Speyer) in California, and from *Isia isabella* A. and S., *Vanessa atalanta* (Linn.), and many other moths and butterflies throughout North America. It occurs also in Oregon in the west.

Zenillia reclinata Aldrich and Webber has been reared commonly from *Estigmene acræa* (Drury) in New Mexico and Arizona and from other caterpillars in the east.

Zenillia vulgaris (Fallén) has been bred from *Pieris rapæ* (Linn.), *Harmologa fumiferana* (Clem.), *Cirphis unipuncta* (Haw.), and other caterpillars

[1] *Can. Ent.*, 45, p. 70, 1913.
[2] Bul. 115, pt. 5, Bur. Ent. U. S. Dept. Agr. p. 102, 1913.

throughout North America. It occurs in Idaho, Washington, and British Columbia in the west.

Phorocera claripennis Macquart is 4.5–9 mm. long, silvery cinereous, with dark thoracic vittæ, and black abdomen with the sides of the second abdominal segment rufous. It is a very common and beneficial species throughout North America and has been reared from caterpillars or pupæ of *Sphinx chersis* (Hbn.) and *Cirphis unipuncta* (Haw.) in Canada; *Neleucania albilinea* (Hbn.) in British Columbia; *Agrotis ypsilon* (Rott.), *Malacosoma disstria* Hbn., *Hemileuca electra* Wright, *Apantesis proxima* (Guér.), *Dione vanillæ* (Linn.), and *Hyphantria cunea* (Drury) in California; *Eurymus eurytheme* (Boisd.) in California and Utah (Wildermuth); *Lycophotia margaritosa* (Haw.) in Oregon (Cole and Lovett); *Hemileuca nevadensis* Stretch in New Mexico; *Scotogramma trifolii* (Rott.) in Colorado; *Alabama argillacea* (Hbn.), *Heliothis obsoleta* (Fabr.), *Hemerocampa leucostigma* (A. and S.), *Datana ministra* (Drury), *Schizura concinna* (A. and S.), *Anarsia lineatella* Zeller, *Aglais antiopa* (Linn.), and also from the differential grasshopper, *Melanoplus differentialis* (Thos.), in various parts of the United States. It also occurs in Alaska.

Phorocera erecta Coq. is 6–8 mm. long, black, with gray pollinose, the thorax with five black vittæ. It has been reared from *Loxostege similalis* Guenée, *Desmia funeralis* Hbn., *Tortrix citrana* Fernald, and other caterpillars in various parts of the country and ranges west into Idaho, Washington, and California. *Phorocera fuscimacula* Aldrich and Webber has been reared from *Hemerocampa vetusta* (Bdv.) and *Telea polyphemus* (Cramer) in California by the writer.

Phorocera halisidotæ Aldrich and Webber has been reared from *Halisidota maculata* (Harris) in Idaho by C. V. Piper.

Phorocera tachinomoides (Townsend) has been reared from *Malacosoma americana* (Fabr.) in New Mexico, Arizona, and Mexico.

Madremyia saundersi (Will.) (*Phorocera*) is dark metallic blue, 8–9 mm. long, and reared from *Autographa californica* (Speyer) in Washington (Hyslop), *Lycophotia margaritosa* (Haw.) in Oregon and California; *Vanessa carye* (Hbn.) in California; and from moths and butterflies elsewhere in North America.

Frontina armigera (Coq.) has been reared from *Heliothis obsoleta* (Fabr.) in California, *Frontina aletiæ* (Riley), from *Halisidota maculata* (Harris) in California and from *Heliothis obsoleta* (Fabr.) and many other moths in the United States. *Frontina archippivora* Williston is a western species reared from *Agrotis ypsilon* (Rott.), *Laphygma exigua* (Hbn.), *Malacosoma pluvialis* (Dyar), *Eurymus eurytheme* (Bdv.), *Pieris rapæ* Linn., *Vanessa cardui* (Linn.), and *V. carye* (Hbn.) in California; *Danaus menippe* (Hbn.), *Malacosoma constricta* (Stretch) in Washington, in Idaho by Aldrich, and in Colorado by Coquillett; *Eurymus eurytheme* (Bdv.) in Utah. The fly also occurs in Arizona, Texas, and the middle States.

Frontina frenchi Will. is a very important and abundant parasite throughout North America. The adults are 5–11 mm. long and gray in color. In the Western States the species has been reared in great numbers from the pupæ of *Telea polyphemus* (Cram.), *Malacosoma californica* (Pack.), *M. disstria* Hbn., *Hemerocampa vetusta* (Bdv.) in California by the writer, and from *Malacosoma constricta* (Stretch), *Papilio rutulus* Bdv., and *Da-*

tana ministra (Drury) in British Columbia by Tothill; from *Smerinthus cerisyi* (Kirby) and a sphingid larva on cottonwood [*Pachysphinx modesta* (Harris?)] in Oregon by Cole and Lovett; from *Neleucania albilinea* (Hbn.) in Colorado, and from a great variety of caterpillars throughout North America.

Sturmia albifrons Walker is a beautiful gray species 9–11 mm. long, reared from *Estigmene acræa* (Drury) and *Cirphis unipuncta* (Haw.) in large numbers in California. *Sturmia distincta* (Wiedemann) is a large beautiful gray species 7–10 mm. long, with the tip of the abdomen orange. It has been reared in large numbers from the chrysalids of *Pholus achemon* (Drury) in California by the writer. *Sturmia inquinata* Van der Wulp has been reared from *Sphinx chersis* (Hbn.), *Celerio lineata* (Fabr.), *Protoparce quinquemaculata* (Haw.), *P. sexta* (Johan.), and *Hemileuca maia* Drury in the west. It is known in Colorado, California, Oregon, Mexico, and Eastern States. *Sturmia schizuræ* Coq. has been reared by Piper from *Schizura ipomϾ* Dbld. in Washington. *Masicera eufitchiæ* Townsend has been reared from *Itame ribearia* (Fitch) by Gillette and from *I. flavicaria* (Pack.) and *I. quadrilinearia* (Pack.) by Baker in Colorado, and from *Hyphantria cunea* (Drury) in California. The fly also occurs in the east.

The tussock moth tachina, *Tachina larvarum* (Linn.) (*T. mella* Walker), is 6–13 mm. long and dark gray, the thorax with black vittæ. It is well distributed throughout North America and has been reared from *Hemerocampa vetusta* (Bdv.) and *H. oslari* (Barnes) in California (Burke); *Datana ministra* (Drury) in British Columbia (Tothill); *Malacosoma californica* (Pack.) in California and Colorado (Gillette); *M. disstria* Hbn., *M. constricta* (Stretch) in California; *M. fragilis* (Stretch) in Colorado (Baker); *Estigmene acræa* (Drury), *Isia isabella* (A. and S.) in California; *Apantesis blakei* Grote *superba* Stretch and *Danaus menippe* (Hbn.) in Colorado (Gillete); *Hemileuca oliviæ* Ckll. in New Mexico (Ainslie), and from many other moths and butterflies throughout the country. In the west the fly also occurs in Oregon, Washington, and Nevada. *Tachina robusta* (Townsend) has been reared from *Hemerocampa vetusta* (Bdv.), *Malacosoma disstria* Hbn., and *Agrotis ypsilon* (Rott.) in California. It is common in Oregon and occurs in Washington and throughout the United States. *Tachina rustica* Fallén ranges throughout North America and the west, being recorded in Colorado, Idaho, Washington, Oregon, and California. The only known host is a sawfly.

The burnt tachinia, *Blepharipeza adusta* Loew, is a large robust species 10–14 mm. long, the head gray, thorax dull black, and the scutellum and abdomen reddish brown, the latter with black median longitudinal and transverse lines. The bases and front margin of the wings are stained brownish. The body is clothed with long stiff hairs which are more abundant at the tip of the abdomen. It is a common parasite in California on *Malacosoma disstria* Hbn., *M. constricta* (Stretch), *Estigmene acræa* (Drury), *Halisidota caryæ* (Harris), *H. maculata* (Harris), *Hemihyalea edwardsi* (Pack.), *Arachnis picta* Pack., and occurs in Oregon, British Columbia, Colorado, North America, and South America.

The red-tailed tachina fly, *Winthemia quadripustulata* (Fabr.), is 6–12 mm. long, gray with the palpi and scutellum yellowish, and the tip of the

abdomen orange. The yellow scutellum readily separates it from *Sturmia distincta* (Wied.), which also has the tip of the abdomen the same color. It is perhaps the best known tachina fly throughout North America and occurs also in Europe. There are many hosts including *Cirphis unipuncta* (Haw.) and *Lycophotia margaritosa* (Haw.) in Oregon (Cole and Lovett); *Heliothis obsoleta* (Fabr.), *Hemerocampa leucostigma* (A. and S.), *Datana ministra* (Drury), *Telea polyphemus* (Cram.), *Protoparce sexta* (Johan.), *Celerio lineata* (Fabr.), *Alypia octomaculata* (Fabr.). *Winthemia fumiferana* Tothill is 7–9 mm. long, black or gray, with palpi, scutellum, antennæ, and the sides of the second and third abdominal segments yellow. It is parasitic on *Harmologa fumiferana* (Clem.) in British Columbia.

Gonia capitata (De Geer) is 9–14 mm. long, black, the sides of the abdomen partly or wholly reddish or yellow, and the base of the last three segments gray pollinose. It is a European species which ranges through the northern part of the United States and Canada, and in the west occurs in British Columbia, California, and New Mexico, breeding in cutworms including *Lycophotia margaritosa* (Haw.) in California and Colorado, *Euxoa ochrogaster* (Gn.) (Tothill) and *Porosagrotis orthogonia* Morr. (Strickland) in Canada, and *Heliothis obsoleta* (Fabr.), throughout the country.

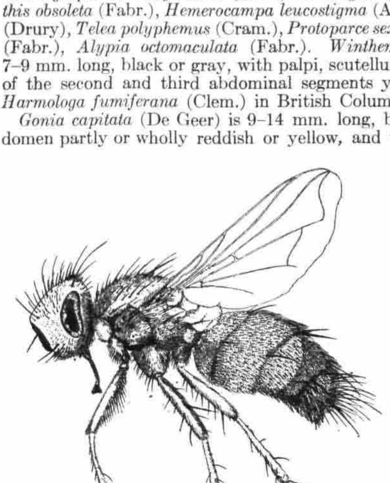

FIG. 471.—The tachina fly, *Gonia porca* Williston.

Gonia porca Williston (*G. sequax* Will.) (Fig. 471) is 13 mm. long, with the abdomen wholly red, excepting the base, tip, and a median dorsal line which are black. It is a common conspicuous species in California and Oregon and has been reared from *Lycophotia margaritosa* (Haw.), *Cirphis unipuncta* (Haw.) and other cutworms.

Chætogædia crebra (Van der Wulp) is 9 mm. long, cinereous with thoracic vittæ; abdominal reflecting spots; and the antennæ, except the base of the female, and legs, except the hind tibiæ, black. It has been reared from *Eriopyga rufula* (Grote) and other cutworms in California, and from *Neophasia occidentalis* Reak. in New Mexico (Cockerell). It ranges also into Mexico.

Chætogædia monticola (Bigot) has been reared from *Vanessa cardui* (Linn.) in Oregon (Cole and Lovett) and California, and from *Lycopho-*

tia margaritosa (Haw.) in Colorado and California (Coquillett). It also occurs in Hawaii.

The robust tachina fly, *Peleteria robusta* (Wied.), is 10–14 mm. long, black, the abdomen reddish with the second and third segments largely or wholly gray pollinose. It ranges through South and North America and occurs in practically every Western State, having been recorded in New Mexico, Arizona, Wyoming, Idaho, British Columbia, Washington, Oregon, California. It is a common parasite on *Hemerocampa vetusta* (Bdv.) in California and on *Porosagrotis orthogonia* Morr. in Alberta (Strickland). *Peleteria tessellata* (Fabr.) has been reared from *Chorizagrotis auxiliaris* (Grote) by Cooley in Montana. It is European, ranging throughout North America, being recorded from British Columbia, Washington, Colorado, and New Mexico in the west.

Archytas analis (Fabr.) is 11–15 mm. long, the thorax gray with five black vittæ, the abdomen shining metallic blue, the fourth segment pollinose, the sides and tip yellow. It ranges throughout North and South America and has been reared from *Malacosoma fragilis* (Stretch) and *Lycophotia margaritosa* (Haw.) in Colorado and from the latter and *Malacosoma californica* (Pack.) in California. It is also known in Arizona and New Mexico.

The spiny tachina fly, *Paradejeania rutilioides* Jænnicke (Fig. 472), is a large, robust, densely spiny fly 16–18 mm. long, dark brownish or black, the thorax, scutellum, and the abdomen, except a dorsal line and a few spots, yellowish or orange. The whole aspect, however, is very dark because of the black spines and smoky wings. It ranges from Central America through Mexico into New Mexico, Arizona, Colorado, and California.

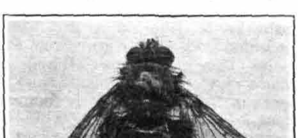
FIG. 472.—The spiny tachina fly, *Paradejeania rutilioides* Jænnicke.

SARCOPHAGIDÆ.[1] Flesh Flies.

Sarcophaga cooleyi Parker is light gray and 10–14 mm. long. It is a scavenger breeding in carrion, garbage, and excrement in Montana. *S. davidsoni* Coq. is a black species 5 mm. long which has been reared from the eggs of the spiders, *Argiope argentata* Fabr. and *Phidippus orpifex* McCook, in Southern California. *Sarcophaga eleodis* Aldrich is gray pollinose with black vittæ, genitalia red, and the body 9 mm. long. It larviposits on adult beetles of *Eleodes obsoleta* (Say), and according to G. W. Barber[2] the maggots enter the anal opening and eventually kill the beetles.

[1] J. M. Aldrich, "Economic Relations of the *Sarcophagidæ*." *Jour. Econ. Ent.*, 8, 1915, p. 242. "*Sarcophaga* and Allies." *The Thomas Say Foundation, Ent. Soc. Am.*, 1916.
T. L. Patterson and W. F. Fiske, "Investigation into Habits of Certain *Sarcophagidæ*." *Tech. Ser.* 19, pt. 3, Bur. Ent. U. S. Dept. Agr. 1911.
C. T. Greene, "Puparia and Larvæ of Sarcophagid Flies." *Proc., U. S. Nat. Mus.*, 66, art. 29, pp. 1–26, 1925.

[2] *Jour. Econ. Ent.*, 11, 1918, p. 268. Also see J. M. Aldrich, *Sarcophaga and Allies*, 1916, p. 128.

According to J. M. Aldrich, Mr. J. S. Wade has made the following rearings: from *Eleodes extricata* (Say), *E. tricostata* (Say), *E. hispilabris* (Say), *E. fusiformis* Lec., and *E. obsoleta* (Say) in New Mexico, and from the latter and *Euschides* (*Asida*) *obovatus* (Lec.) in Colorado. *Sarcophaga hæmorrhoidalis* (Fallén) (*S. georgina* Wied.) is a large species 10–14 mm. long and gray pollinose. It has been reared from human excrement in Montana by J. R. Parker. The larvæ have been passed through the alimentary canal in human feces and may be a cause of intestinal myiasis in man. It is a world species being known in Europe, Asia, Africa, and North America. In the west it is recorded from New Mexico, Colorado, and has been reared from *Melanoplus differentialis* (Thos.) in Wyoming.[1] *Sarcophaga helicis* Townsend is silvery and black, and 3–8 mm. long. It is the commonest North American species and was originally reared from a snail in Ohio. A. W. Morrill[2] has reared it from the larvæ of *Heliothis obsoleta* (Fabr.) in Arizona, and J. M. Aldrich[3] reports it from the larvæ of *Cirphis unipuncta* (Haw.) in Indiana and from the larvæ of the palm beetle, *Dinapate wrighti* Horn, in Southern California. It is also recorded from a white grub, from *Pieris rapæ* (Linn.), *Melanoplus differentialis* (Thos.), *M. atlanis* (Riley), *Aglais californica* (Bdv.), and *Eleodes opaca* (Say), *Tibicen linnei* (S. and G.), *Corydalis cornuta* (Linn.), and the larva of *Calosoma* sp. It is common in practically every State. *Sarcophaga kellyi* Aldrich is 6.5–7.5 mm. long, gray with black vittæ, the fifth sternite reddish brown, and is a very efficient natural check on grasshoppers. The adults larviposit on the grasshoppers, often attacking them in flight and bringing them to the ground. It has also been reared from a cerambycid borer and from a tenebrionid beetle. It is reported in Montana, Colorado, and Oregon, but probably has a wider western distribution. *Sarcophaga opifera* Coq. is gray pollinose with blackish stripes and 5.5–6.5 mm. long. It is parasitic on *Melanoplus devastator* Scudd. in California and on *M. differentialis* (Thos.) in Arizona, and from *M. atlanis* (Riley), *M. bivittatus* (Say), and other grasshoppers in various parts of the west, also being known in New Mexico, Washington, and Texas. *Sarcophaga hunteri* Hough is gray pollinose with black legs. It is parasitic on grasshoppers and has been reared from *Melanoplus atlanis* (Riley) and *M. differentialis* (Thos.). It ranges in many parts of the country and is reported in British Columbia, California, Utah, Idaho, Arizona, and New Mexico in the west. *Sarcophaga aldrichi* Parker is 8–10 mm. long and gray pollinose. It has been reared from *Malacosoma disstria* Hbn. in Washington and also occurs in British Columbia and the east. *Sarcophaga tuberosa* Pand. var. *sarracenioides* Aldrich is 8–13 mm. long, gray with the fourth abdominal segment largely red. It has a wide distribution in this country and has been reared from carrion, excrement, *Melanoplus differentialis* (Thos.), and other grasshoppers, *Anabrus* sp., *Cirphis unipuncta* (Haw.), *Chorizagrotis agrestis* (Grote), *Phyllophaga* spp., *Eleodes tricostata* (Say), and *Cotinis nitida* (Linn.). In the west it is recorded in British Columbia, Washington, Idaho, Colorado, and Arizona.

[1] F. M. Webster, *Bul.* 67, *Bur. Ent. U. S. Dept. Agr.* 1907, p. 98. Also see J. M. Aldrich, *Sarcophaga and Allies*, 1916, p. 189.

[2] *Ninth Ann. Rept.*, Ariz. Com. Agr. & Hort. 1917, p. 57.

[3] *Jour. Econ. Ent.*, 8, 1915, p. 244.

CALLIPHORIDÆ and MUSCIDÆ.[1] Blow Flies, House Flies, etc. The members of these two families are among the very most important ones because of the fact that the house fly spreads such serious diseases as typhoid, summer diarrhœa, cholera, amœbic and bacillary dysentery, diphtheria, infantile paralysis, and many other ailments, to say nothing of the blowing of meat by the blow flies, and the damage and annoyance to domesticated animals by the sheep maggot flies, the stable fly, and others.

The cluster fly, *Pollenia rudis* (Fabr.), is slightly larger than the house fly, readily distinguished by the pale golden pile, the checkered black and silvery abdomen, and by the overlapping of the wings at rest. The adults often collect in great numbers in houses during the winter, hibernating on the reverse sides of pictures hanging on the walls or in other dark places. The larvæ are supposed to be parasitic on earthworms. It occurs throughout Europe and North America and is common in Oregon, California, and probably most of the other Western States.

The screw worm, *Cochliomyia macellaria* (Fabr.) (*Chrysomyia*),[2] is somewhat larger than the house fly, dark bluish green with three dark vittæ on the thorax, and a yellow or reddish face. The small creamy white eggs are laid in masses of 40 to 250 in carcasses or in open sores or wounds of living animals, or in the ears, nose, navel of calves and bruises or cuts where dried blood collects. Serious injury or death may result from the presence of the maggots in the flesh. They grow rapidly and mature in 4 or 5 days, while in dead carrion they require from 6 to 20 days. When mature they drop to the ground and pupate several inches beneath the surface, the adults emerging in from 3 to 14 days. The entire life cycle is completed in from 7 to 28 days. There are several broods a year. Among the hosts, cattle suffer most, after which come hogs, horses, mules, sheep, goats, and dogs in the order named. Wild deer, other animals, and even man may be subjects of attack. The species is native to North and South America and is found in every part of the United States. The complete destruction of carcasses by burning or deep burying, preventing or properly caring for wounds, and caring for young calves are suggested means of control.

The bluebottle or common blow flies, *Calliphora erythrocephala* (Meigen) and *C. vomitoria* (Linn.), are known to all. The length averages 10 mm. The large red eyes, dark grayish thorax, and metallic blue abdomen are well known. They are separated by the cheeks, which in the former are orange and in the latter black. The bodies are covered with long fine hairs. The adults are abundant in many parts of the west throughout the year and continually collect at windows inside houses. They readily blow meat if available and regularly breed in dead animal matter.

The greenbottle fly, *Lucilia sericata* (Meigen) (Fig. 473), is clear, metallic, shining bright emerald or bluish green without markings and smaller than the bluebottle fly and but slightly larger than the house fly. It is the common species in our region. It is abundant throughout the summer and is more rarely a household nuisance. The larvæ feed in carrion, manure, garbage, and other refuse. It is European in origin but is now nearly cosmopolitan. *L. cæsar* (Linn.) is similar in size and appearance but less abundant, although a widely distributed European species common everywhere in North America. Both species have been recorded as wool maggots of sheep, the former being specially troublesome in Australia.

[1] R. C. Shannon, *Ins. Insci. Menstr.* 11, p. 101, 1923; 12, p. 67, 1924.
The first six species are now placed in the *Calliphoridæ* and the last four in the *Muscidæ*.

[2] F. C. Bishopp, J. D. Mitchell, D. C. Parkman, *Farmers' Bul.* 857, 1922.

The black blow fly, *Phormia regina* Meigen, is blue-green, dark blue, or greenish black, somewhat more robust than the greenbottle flies but of similar breeding habits and is responsible for most of the trouble from wool maggots in the southwest. It is common in Europe and North America and abundant in the west.

Protocalliphora azurea (Fallén) is a metallic blue European species distributed in various parts of North America. The larvæ occur in birds' nests and suck blood from the nestlings. They may be sufficiently numerous to kill not only the very young but also those nearly full fledged. In California, O. E. Plath[1] has taken maggots of this fly from the nests of Nuttall sparrow, California purple finch, green-backed goldfinch,

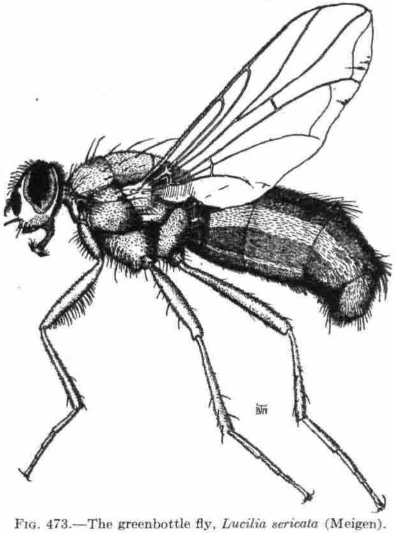

FIG. 473.—The greenbottle fly, *Lucilia sericata* (Meigen).

willow goldfinch, California brown towhee, and California linnet. The fly also occurs in Oregon.

The house fly, *Musca domestica* (Linn.) (Fig. 474), is one of the greatest scourges of the human race with which it has always been associated. Nearly everyone thinks he knows the house fly, but as a matter of fact, few people are able to distinguish the genuine species from several closely related house infesting flies. The adults are 4 to 6 mm. long, gray with four dark vittæ on the thorax, and irregular dark markings with a distinct dark median line on the gray or yellowish abdomen. The wings are usually folded almost straight backwards over the body and not at an angle when at rest. The habits and life history of this disease-carrying fly are so well

[1] *Univ. Cal. Pub. Zoölogy*, 19, No. 5, 1919, p. 191.

known as to need no further discussion here. Suffice it to point out the fact that a few years ago flies were allowed free leave to walk over the food on private and public tables alike, but the public mind has been so thoroughly aroused as to make such a condition at the present time impossible in all places, excepting those of filth and ignorance. The breeding in

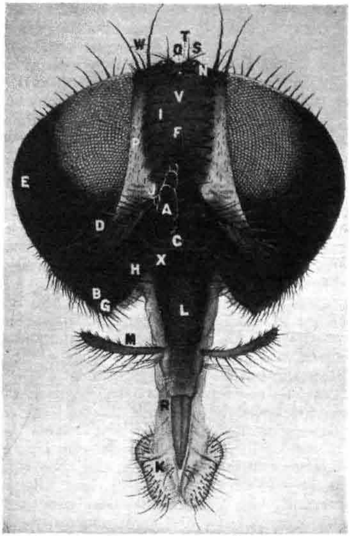

FIG. 474.—Head of the house fly, *Musca domestica* (Linn.), showing parts: A, antenna; B, bucca or portion between genæ and eye; C, clypeus; D, arista; E, compound eye; F, front or frontal vitta; G, gena or cheek; H, facial bristles, I, frontal bristles; J, frontal suture; K, labella or oral lobe; L, labrum; M, maxillary palpus; N, greater ocular bristles, a pair just back of the front ocellus; O, ocelli or simple eyes; P, genovertical plâte; R, labium; S, lesser ocular bristles, several or many pairs extending backward from the ocelli; T, ocellar triangle, formed by the three ocelli; V, vertex, the portion of the front between the compound eyes or the upper portion of the front; W, vertical bristles, an inner and outer pair inserted behind the upper and inner corners of the compound eyes; X, vibrissæ, a pair of stout bristles, one on each side of face, near or just above the oral margin. (After Herms, original lettering.)

manure, garbage, and other filth, the feeding of the flies on disease-bearing materials of all sorts, and the knowledge of the danger of the dissemination of dreaded human diseases have brought about a very important and necessary change in attitude towards this most offensive insect. H. E. Ewing has observed a parasitic mite, *Macrocheles muscæ* Ewing, which

becomes attached to the ventral base of the abdomen and is carried about, at Corvallis, Oregon.

The stable fly or biting house fly, *Stomoxys calcitrans* (Linn.) (*Conops*) [1] (Fig. 427), is very similar to and often associated with the house fly. It is distinguished by the more pronounced and interrupted dorsal vittæ of the thorax, the shorter, checkered abdomen, the prominent slender proboscis, and the angular poise of the wings when at rest. The adults are abundant out of doors but readily invade buildings, and often prove a great nuisance in houses. They are bloodsuckers and serious tormentors of man and domestic animals which they bite with avidity. The larvæ breed normally in decaying grass or straw and often occur in enormous numbers in piles of lawn clippings which can become sources of serious invasions of the flies. Some breeding occurs in manure and other waste vegetable materials. The species is distributed throughout Europe and North America and, with the house fly, occurs wherever there are habitations. The adults are suspected of carrying several human diseases.

The squash root maggot, *Muscina assimilis* (Fallén) (*Cyrtoneura cæsia* Meigen),[2] is a European species introduced into many parts of the United States. In Colorado the larvæ have been observed to mine and destroy the roots of young squash plants [3] and to work also in the rotten roots [4] of the same host. In California it is a common species and the adults have been reared from partly decomposed watermelon and other vegetable matter. In Europe it breeds in mushrooms. It also occurs in Oregon. *M. stabulans* (Fallén) is sometimes a household nuisance. The maggots breed in decomposed vegetable matter and are supposed also to be parasitic or predaceous on caterpillars. The species, generally, occurs throughout the United States and probably occurs in most of the Western States.

The horn fly, *Hæmatobia serrata* Desvoidy, is considerably smaller and more slender than the house fly, although of about the same color. The palpi are nearly as long as the proboscis. The fly gets the common name from the habit of resting in great numbers at the bases of the horns of cattle, but it also gathers on the rump, neck, and sides as well. The adults are vicious biters, greatly torment domestic and wild animals, and are persistent annoyers of man, though not usually because of their bite. They remain on the livestock day and night and cause loss of vitality and reduce efficiency of milk cows. The maggots breed in manure. The fly was introduced from Europe, being first discovered in America in 1887. It has since spread over the entire country.

ANTHOMYIDÆ.[5] Root Maggots.

The onion maggot, *Hylemyia antiqua* (Meigen) (*Phorbia ceparum* Meig.) (Figs. 475, 476), in the adult stage, is 3–4 mm. long, dull gray or brown,

[1] F. C. Bishopp, *Farmers' Bul.* 540, U. S. Dept. Agr. 1913.

[2] This species has often been confused with *Muscina stabulans* (Fallén) in economic literature.

[3] D. W. Coquillett, *Insect Life*, 7, 1895, p. 338.

[4] C. F. Baker, *Ent. News*, 6, 1895, p. 174.

[5] Also commonly spelled *Anthomyiidæ*.

D. W. Coquillett, "Types of Genera." *Jour. N. Y. Ent. Soc.*, 9, 1901, p. 134.

J. R. Malloch, "*Anthomyidæ* from South Western U. S." *Trans. Am. Ent., Soc.* 44, 1918, p. 263. New N. A. "*Anthomyidæ*." *Trans. Am. Ent. Soc.*, 46, 1920, p. 133.

with four dark thoracic vittæ and a dark line on the abdomen of the males. The flies appear in May and June. The cylindrical white eggs are laid about the bases of the plants and the white maggots attack the crown and bulbs of the onions causing serious losses to small and large plants. The larvæ pupate in the soil, the small reddish brown puparia occurring in the decayed onions or near by in the ground. There are 2 or 3 generations annually. The pest is so serious in some localities that onion-growing has been discontinued. Garlic is also infested. The fly is European and has become generally distributed throughout North America. In the west it occurs in British Columbia, Montana, Oregon, California, and Colorado. Control measures[1] consist in destroying

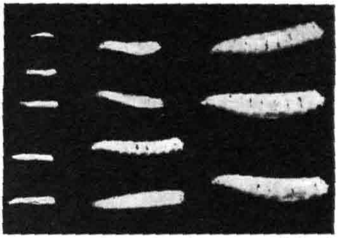

FIG. 475.—Larvæ of the onion maggot, *Hylemyia antiqua* (Meigen). (Photo furnished by H. H. P. Severin.)

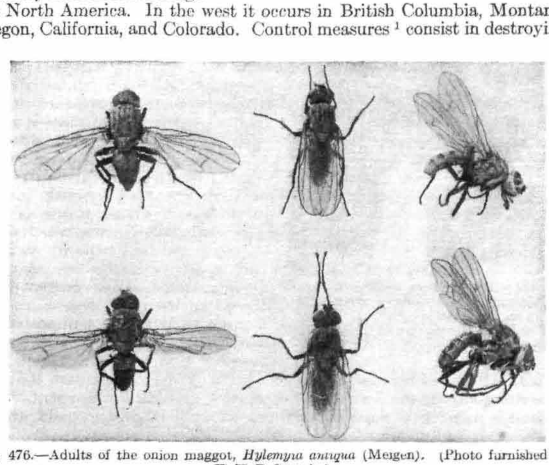

FIG. 476.—Adults of the onion maggot, *Hylemyia antiqua* (Meigen). (Photo furnished by H. H. P. Severin.)

all of the infested onions after harvest and stirring the ground as much as possible to expose the pupæ to the elements. Spraying the young plants

[1] H. H. P. Severin, *Jour. Econ. Ent.*, 8, 1915, p. 342.
A. L. Lovett. *Circ.* 37, Ore. Agr. College, 1923.

several times during the egg-laying season in the spring or early summer with a bait composed of $^1/_5$ ounce sodium arsenite or white arsenic, 1 gallon of water (hot for mixing), and 1 pint of black molasses, has given satisfactory results in the east. A container holding the liquid, with a float as a place for the flies to alight and lap up the sweetened poison, has also been used successfully. Cull onions set out early as a trap crop and destroyed after egg-laying is recommended by Lovett. Also use corrosive sublimate as recommended for the cabbage maggot.

The western wheat stem maggot, *Hylemyia cerealis* (Gillette),[1] is 5.5 mm. long, and gray with dark thoracic vittæ. The maggots are yellowish white, 6 to 7 mm. long. They mine the stems of spring, fall, and winter wheat causing serious losses in some sections of Colorado and Montana. Summer fallow, clean culture, and reseeding are suggestions for control.

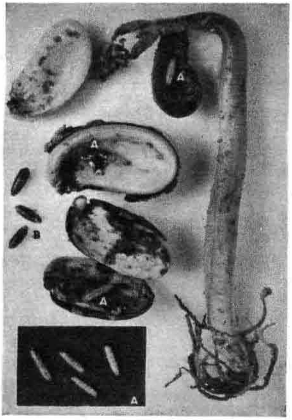

FIG. 477.—The seed corn maggot, *Hylemyia cilicrura* (Rondani), showing work of maggots on germinating beans. A, maggots; B, puparia. (Photo furnished by H. H. P. Severin.)

The seed corn maggot, *Hylemyia cilicrura* (Rondani) (*Phorbia fusciceps* Zetterstedt)[2] (Fig. 477), is a small light gray fly 5 mm. long, and distinguished by the row of short even hairs on the inner side of the hind tibiæ. The whitish maggots attack the planted seed of a number of crops during the winter and early spring months, particularly if there is a cold spell which prevents quick germination of the seed. Beans, peas, barley, wheat, corn, melons, cucumbers, and potatoes are often seriously injured in this way. Young plants of cabbage, corn, beets, beans, peas, onions, potatoes, turnip, spinach, radishes, and sweet potatoes, are also frequently killed. The maggots also breed in decayed vegetation and manure. The fly is a common widely distributed European species known to occur in the west in Oregon, California, Arizona, Colorado, and New Mexico, and throughout the east. Reseeding affords the best means of control, as little injury results if the ground is sufficiently warm to secure rapid germination and quick growth of the seeds and plants.

The cabbage maggot, *Phorbia brassicæ* (Bouché) (*Pegomyia, Chortophila planipalpis* Stein)[3] (Figs. 478–480), is the best known and most

[1] C. P. Gillette, Bul. 94, Colo. Agr. Exp. Sta. 1907, p. 14. 12th *Ann. Rept. Ent. Colo.* 1921, p. 18.

[2] E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 334.

[3] E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 336.
A. L. Melander and M. A. Yothers, Bul. 136, Wash. Agr. Exp. Sta. 1917.
This fly is also known as the western radish maggot. What is also supposed to be this

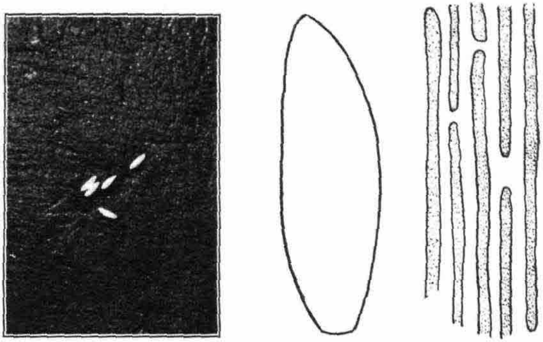

FIG. 478.—The cabbage maggot, *Phorbia brassicæ* (Bouché). Eggs deposited on **radish and** a greatly enlarged drawing showing the outline and the sculpture on the surface.

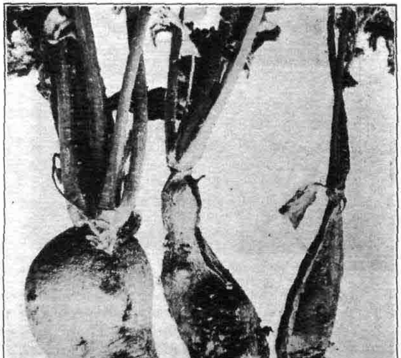

FIG. 479.—Radishes showing characteristic work of the larvæ of the cabbage maggot, *Phorbia brassicæ* (Bouché).

destructive root maggot and one concerning which many bulletins have been written. The adults are pale or dark gray, 5 mm. long, with black vittæ on the thorax. The eggs are 0.8 mm. long, white and marked with minute longitudinal furrows. They are laid in the spring, singly or in masses on the stems or roots just below or at the surface of the ground each adult laying from 50 to 200. They hatch in two or three days and the whitish maggots begin to work their way into the roots and stem of the plants. When mature they are 6 to 10 mm. long. Young plants of cabbage, cauliflower, brussels sprouts, and kale, may be entirely eaten out at the

FIG. 480.—Puparia of the cabbage maggot, *Phorbia brassicæ* (Bouché), in the soil about the roots of the host plants.

stem and killed in short order; while the fleshy roots of radishes, and turnips, may be entirely riddled with holes. There are several broods each year. Practically all cruciferous plants are attacked. Many other plants are listed as hosts which are probably attacked by a different species. The cabbage maggot is a European species now distributed throughout North America and a common pest in many Western States. It is the only insect pest of importance at Sitka, Alaska, and is reported from British Columbia, Washington, Idaho, Montana, Colorado, Oregon, and California. Control measures consist in three applications of corrosive

fly is abundant in the developing seed pods of various species of lupines in California, Oregon, and Washington. J. A. Hyslop has described it as the lupine pod borer in Washington. (Bul. 95, pt. 6, Bur. Ent. U. S. Dept. Agr. 1912, p. 105.) Coquillett had described a maggot in the stems of lupines in California as *Phorbia lupini* Coq. It also infests the roots of locoweed in Colorado and Arizona and is in such cases called the locoweed maggot. Several species are probably mixed here.

sublimate, one ounce to 10 gallons of water, at the rate of about ¼ pint poured on and around a single plant. The first application should be made about three days, the second 9 or 10 days, and the third 19 to 20 days, after transplanting. The applications can be made with a sprinkling can. None of the solution should be used on plants after they are half grown for fear of poisoning the consumers, and would thus be useless as a means of control. Tarred discs placed snugly about the plants at the surface of the ground when transplanted have long been used with a marked degree of success. A number of natural enemies are reported in the east, but none affords

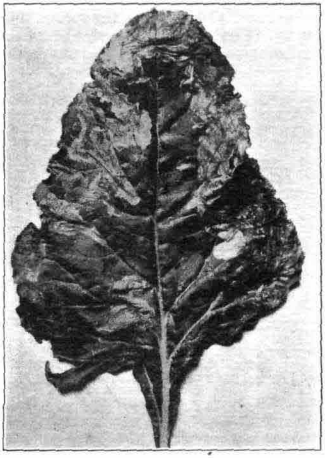

FIG. 481.—Beet leaf showing mines of the larvæ of the beet or spinach leaf miner, *Pegomyia hyoscyami* (Panzer).

an effectual check. Winter-grown cruciferous crops largely escape the attacks of this fly.

The raspberry cane borer, *Phorbia rubivora* Coquillett, is very similar to the others already described. The eggs are laid in the leaf axils of the tender tips of new canes of blackberry, dewberry, loganberry, raspberry, roses, and so on, and the maggots girdle the tip and mine down the tender shoots causing them to die. The species occurs in the east and is known in British Columbia, Idaho, Oregon, and California in the west.

The beet or spinach leaf miner, *Pegomyia hyoscyami* (Panzer) (*P. vicina* Lintner) (Figs. 481, 482), is a slender gray fly, 5 mm. long, with white face. The eggs are elongated, white, with mosaic sculptured surface composed of many short broken ridges. They are laid singly or side by side in small groups of four to eight, usually on the undersides of the leaves,

and hatch in three or four days. The small pale greenish or whitish maggots enter the leaf tissues and feed between the two surfaces causing a large colorless blotch or mine. Where they are numerous, the entire leaf may be completely destroyed. If the infested leaves are held to the light, the maggots may be readily seen in the mines. When mature they are 8 mm. long. They then go into the ground for pupation and hibernation. There are several broods annually. Like its close relatives, this is an introduced European species occurring throughout North America. In the west it is known in Oregon, California, and Colorado. Spinach, beets of all varieties, and lambsquarters are attacked. Canning spinach is grown in California during the winter and is harvested in the spring, thus entirely escaping the attacks of this fly. Control measures consist in cleaning up infestations before the maggots leave the mines, in clean culture, crop rotations,

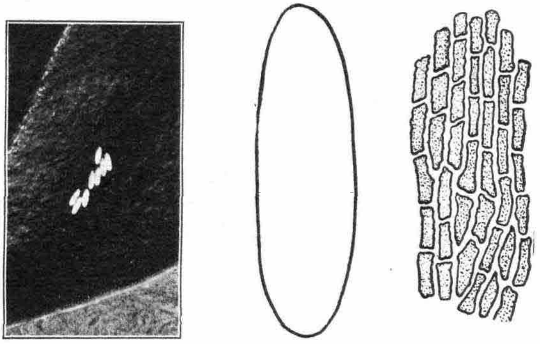

FIG. 482.—Eggs of the beet or spinach leaf miner, *Pegomyia hyoscyami* (Panzer), in characteristic group on beet leaf and large drawings to show outline and sculpture on the surface.

and in winter cropping wherever possible. H. H. P. Severin has secured control on beets by spraying with 1-½ pints of 40 per cent nicotine sulfate to 100 gallons of water. *Pegomyia bicolor* (Wied.) mines the leaves of dock in Oregon (Cole and Lovett) and in California.

The lesser house fly, *Fannia canicularis* (Linn.) (*Homalomyia*), is a very common, house-infesting species of the same general appearance as the house fly, but smaller, 3–5 mm. long, and more slender. The third vein near the tip of the wing continues straight to the margin instead of curving upward to meet the second vein, and the arista is not plumose as in the house fly. **The latrine fly,** *Fannia scalaris* (Fab.), is slightly larger with bluish black thorax and abdomen. Both of these flies breed in decaying vegetation and excrement of humans and animals, are not desirable to have about the house, and may be dangerous disseminators of intestinal diseases. They are European species generally distributed throughout this country.

The kelp fly, *Fucellia rufitibia* Stein, is a small, slender gray fly, 3 mm. long, with reddish tibiæ, which swarms about the fresh and drying piles of kelp along the coast of Central and particularly Southern California. It is often so abundant as to com-

pletely hide the large masses of kelp on the beaches. *F. costalis* Stein is a larger, quick fly which is partially predaceous on sand fleas on the beaches of Southern California.[1]

Acalyptratæ (Group)

The members of this group have the calyptra or squamæ absent or rudimentary; the thorax without complete transverse suture; the first longitudinal vein usually terminating in costa at or beyond the middle of the wing or near the base of the wing.

KEY TO FAMILIES

(Adapted from Williston, Cole, Lefroy, Brown and others)

1. Subcostal vein present and nearly as thick as the first longitudinal; the latter generally terminating in costa at or beyond middle of wing 2
   Subcostal vein absent or rudimentary and much thinner than the first longitudinal vein; the latter as a rule ends before middle of costal margin and often near the base of wing 16

2. Vibrissæ present and usually conspicuous 3
   Vibrissæ absent or vestigial; mouth only with short hairs but often bare or if the hairs are strong, then they are about the same size 6

3. The point at which median cross vein leaves media is much nearer the radio-medial cross vein, measuring along the media, than it is to the edge of the wing; radius and anal veins short; second basal cell minute; cross veins often approximated; front bristly. Small elongated flies found in woods and shady and marshy places. The larvæ live in decaying wood or under bark . . . . . **Heteroneuridæ**
   The point at which the median cross vein leaves the media about equidistant from the radio-medial cross vein and from edge of wing, or a little nearer the edge 4

4. Costa with row of distinct spines projecting beyond ciliation; tibiæ with spurs and preapical bristles. Medium sized flies living in shady and damp places. The larvæ breed in decayed animal and vegetable matter and dung . . . . . **Helomyzidæ** [2]
   Costa without row of spines, simply ciliated 5

5. Fronto-orbital bristles present; if absent, the body is never shining black; mesonotum convex; more than four abdominal segments visible. Dull medium sized to large species. (Dung Flies.) . . . . . **Cordyluridæ** or **Scatophagidæ** p. 600
   Fronto-orbital bristles absent; body always shining black; wings hyaline, often with spot near apex; abdomen narrow and constricted at base. Small flies . . **Sepsidæ** (part)[3]

6. Antennæ very long and horizontal; second segment as long or longer than third, the upper edge of which is concave 7
   Antennæ short, or if long, drooping rather than horizontal; second segment always shorter than third, the upper edge of which is straight or convex 8

7. Profile normal, the face being perpendicular or only slightly retreating; head short and broad; wings longer than abdomen, usually spotted. Brown or yellowish flies occurring along streams, in marshes and meadows. The maggots are aquatic and have six or eight fleshy processes on the posterior segment **Tetanoceridæ or Sciomyzidæ** (part)[4]

[1] F. R. Cole, *First Ann. Rept.*, Laguna Marine Lab. Pomona College, 1912, p. 156.
[2] J. M. Aldrich and P. S. Darlington, *Trans. Am. Ent. Soc.*, 34, 1908, p. 67.
[3] A. L. Melander and A. Spuler, Bul. 143, Wash. Agr. Exp. Sta. 1917.
[4] E. T. Cresson, Jr. *Trans. Am. Ent. Soc.*, 46, 1920, p. 27.

Profile triangular, face retreating, sometimes almost horizontally; only middle tibiæ spurred; wings often pictured. Small to medium flies. (Ortalid Flies.) **Ortalidæ** (part) p. 605

8\. Adults with flat horny thorax and flat abdomen; with stout mouth hairs. Small brown or black flies often abundant about sea weed on the ocean beaches.... **Phycodromidæ**

Not so characterized.......... 9

9\. Median and cubital cells very small and indistinct.......... 10

Median and cubital cells fairly large and distinct.......... 11

10\. Only *one* fronto-orbital bristle on each side; tibiæ without preapical bristle; anal vein abbreviated, anal cross vein recurved. Small flies often with pictured wings. Larvæ have been taken from the burrows of bark beetles...... **Lonchæidæ**

More than one fronto-orbital bristle on each side; preapical bristle present on at least some of the tibiæ. Small flies. The larvæ are bristly with terminal processes on the last two joints and live on decaying vegetable matter...... **Lauxaniidæ** or **Sapromyzidæ** [1]

11\. Hind tibiæ with preapical bristle......... **Tetanoceridæ** or **Sciomyzidæ** (part)

Hind tibiæ without preapical bristle.......... 12

12\. Lower fronto-orbital bristles present and close to eye; wings usually pictured; cubital or anal cell angular or pointed; subcostal vein sharply curved up at end; female usually with long horny ovipositor. Small to medium-sized flies. (Fruit Flies.).......... **Trypetidæ** p. 600

Lower fronto-orbital bristles absent; subcostal vein gently curved towards costa. 13

13\. Legs long; abdomen narrow and long, constricted at base.......... 14

Legs normal; abdomen comparatively short and broad, never constricted at base. Wings often spotted. (Ortalid Flies.)............ **Ortalidæ** (part) p. 605

14\. Media straight or nearly so; bodies shining black.......... 15

Media strongly curved towards the radius; bodies brown; legs long and slender, hind femora slightly swollen apically; arista plumose; wings large; eyes small; hypopygium often large. Flies predaceous on small insects. **Micropezidæ** (part)

15\. Anal vein reaching wing margin; abdomen long and slender, more than twice as long as thorax; legs long. Small dark flies with long antennæ.... (Rust Flies) **Psilidæ** (part) p. 607

Anal vein not nearly reaching wing margin; abdomen rather broad and only slightly longer than the thorax.......... **Sepsidæ** (part)

16\. Head produced on each side into a lateral process bearing the eye; radial or second basal cell confluent with first discal; front femora swollen. Small naked mostly tropical flies.......... **Diopsidæ**

Head not produced into lateral processes.......... 17

17\. Hind metatarsus usually dilated and shorter than the next segment; antennæ short, arista dorsal or terminal and bare or pubescent. Minute or small black or brownish flies. The larvæ live in fungi and decomposed vegetable matter.. **Borboridæ**

Hind metatarsus not dilated, and longer than the next segment.......... 18

18\. Fourth posterior cell wanting; median cross vein present.......... 19

Fourth posterior cell and median cross vein either both or neither present........ 22

19\. Legs long and thin; abdomen very long.......... **Micropezidæ** (part)

Legs short and strong; abdomen oval or elliptical.......... 20

[1] A. L. Melander, *Psyche*, 20, 1913, p. 57.

20. *Lower fronto-orbital bristles absent; interfontalia large; third antennal segment* round, or if lengthened, the head is triangular in profile; anal and second basal cells absent. Small bare dull or brightly colored flies with short antennæ, legs, wings and abdomen. (Frit Flies.).......... **Oscinidæ** or **Chloropidæ** p. 610
Lower fronto-orbital bristles present; third antennal segment generally long and oval; head never triangular in profile.............................. 21

21. Head large square; face strongly convex; mouth large; oral vibrissæ absent; costa microscopically broken twice. Small dark flies.......... **Ephydridæ** p. 607
*Head round or semicircular; face not arched; oral vibrissæ present; arista plu*mose; costa microscopically broken twice. Small nearly bare yellowish species. (Pomace Flies.)......................... **Drosophilidæ** (part) p. 611

22. Costa thickened from end of subcosta to tip of wing; scutellum of male very long and squared behind................................ **Thyreophoridæ**
Costa normal; scutellum of male usually short and somewhat triangular...... 23

23. Oral vibrissæ present.. 24
Oral vibrissæ absent... 31

24. Fronto-orbital bristles absent....................................... 25
Fronto-orbital bristles present...................................... 26

25. Wings with a black spot near tip......................... **Sepsidæ** (part)
*Wings without black spot near tip; only uppermost fronto-orbital bristles pres*ent; arista bare; mesopleural and prothoracic bristles absent; costa broken near end of first vein; first and fourth veins parallel or slightly diverging; abdomen bare. Small dark flies......................... **Piophilidæ** p. 606

26. Median cross vein before middle of wing; radio-medial cross vein and median cross vein very near to base of wing and exceedingly near to one another, or both $media_3$ and median cross vein missing 27
*Median cross vein at or beyond middle of wing; radio-medial cross vein and me*dian cross vein neither very near the wing base nor to one another.......... 29

27. Median cross vein immediately beneath radio-medial cross vein or nearer to the base of wing, or both $media_3$ and median cross vein absent 28
Median cross vein always present and farther from base of wing than radio-medial cross vein; costa broken once; subcosta indistinct or absent; eyes widely separated; arista pubescent; wings short and rounded. Small flies. The larvæ of many are leaf miners......................... **Agromyzidæ** p.[1] 613

28. Arista bare or nearly so.................................. **Phytomyzidæ** p. 612
Arista with long hairs on one side.................................... **Asteiidæ**

29. Arista bare or pubescent; body short and broad; costa microscopically broken twice; anal cell present; clypeus small; posterior fronto-orbital bristles confluent. Small flies..................................... **Milichidæ**[1]
Arista plumose, combed or distinctly pubescent or if bare the body is narrow and long.. 30

30. Arista thinly but long haired, combed or plumose........ **Drosophilidæ** (part) p. 611
Arista bare or thickly beset with short hair or pubescence; wings large; anal and basal cells complete; costa once broken; subcostal separately ending in costa; clypeus large; foremost fronto-orbital bristles directed backwards; postvertical bristles convergent. Minute flies................ **Geomyzidæ**[1]

31. Medial and cubital cells large and very prominent.......................... 32
Medial and cubital cells small.. 33

[1] A. L. Melander, *Jour. N. Y. Ent. Soc.*, 21, p. 219, 1913.

32. Antennæ moderately long to very long; male hypopygium obscure............ **Psilidæ** (part) p. 607
Antennæ short; male hypopygium prominent and clavate..... **Opomyzidæ** (part)

33. Light gray or silvery pollinose; costa without breaks....... **Ochthiphilidæ** [1] p. 617
Orange or brownish red flies............................ **Opomyzidæ** (part)

CORDYLURIDÆ or SCATOPHAGIDÆ. Dung Flies.

The adults are dull colored flies which hover about dung in barnyards and pastures. They are often predaceous on blow flies, house flies, and other insects. The maggots live in excrement, decayed vegetation, and very rarely in the stems of plants. *Scatophaga stercoraria* (Linn.) is a slender pilose tawny or yellowish brown fly, the males with long pile, very common on cow dung in which the larvæ breed. The adults are predaceous on the blow fly and house fly. The species is cosmopolitan and common in the west. *S. merdaria* (Fabr.) is predaceous on fungus gnats and leafhoppers in Oregon according to Cole and Lovett. It is also a European species of wide distribution. *S. furcata* (Say) ranges from Alaska to California and throughout many parts of North America. The larvæ breed in excrement of all kinds.

TRYPETIDÆ.[2] Fruit Flies.

The adults are small to medium sized, many colored flies, usually with beautifully pictured wings and with the characteristic habit of slowly elevating and lowering their wings when at rest or strutting about on fruit or foliage, which has given them the name of peacock flies. The larvæ are characteristic white maggots living in fruits, berries, husks of nuts, leaves, stems, and other parts of living plant tissues. Some have the ability to throw themselves or to jump.

This is one of the most important injurious families of insects, particularly to horticulture. Among its members are a number of native pests in the Eastern States and a few minor ones in the west. The most important species not yet established in the United States are the **Mediterranean fruit fly,** *Ceratitis capitata* (Wied.) (Fig. 483), which attacks all kinds of fruits and which occurs in tropical and temperate regions of much of the world, including Africa, Southern Europe, and the Mediterranean region, Australia, South America, Bermuda, Hawaii, and many of the South Sea Islands; **the Mexican orange maggot,** *Anastrepha ludens* (Loew) (Fig. 484), which attacks citrus and subtropical fruits in Mexico and Central America; **the South American fruit fly,** *Anastrepha fraterculus* (Wied.) which attacks citrus and subtropical fruits in Brazil, Argentine, and other South American countries; **the Queensland fruit fly,** *Dacus zonatus* Coq., which occurs on many kinds of fruits in Australia; **the olive maggot,** *Dacus oleæ* Rossi, a very serious pest to ripe olives in the Mediterranean

[1] A. L. Melander, *Jour. N. Y. Ent. Soc.*, 21, p. 219, 1913.
[2] R. W. Doane, *Jour. N. Y. Ent. Soc.*, 7, 1899, p. 177.
D. W. Coquillett, *Jour. N. Y. Ent. Soc.*, 7, 1899, p. 259.
A great deal of literature has been written concerning foreign fruit flies which is too voluminous for inclusion here. The student is particularly referred to the following:
W. W. Froggatt, "Fruit Flies." *Farmers' Bul.* 24, Dept. Agr. N. S. W. 1910.
Geo. Compere, *Mthly. Bul.*, Cal. State Hort. Com., 1, 1912, p. 709.
F. Silvestri, *Exped. to Africa in Search of Natural Enemies of Fruit Flies*, etc. Bul. 3, Div. Ent., Ty. of Hawaii, Board of Agr. & Forestry, 1914.
W. D. Pierce "A Manual of Dangerous Insects," etc. *Contrib. Bur. of Ent.*, U. S. Dept. Agr. 1917.
E. A. Back, *The Mediterranean Fruit Fly*. Bul. 640, U. S. Dept. Agr. 1918.
E. A. Back and C. E. Pemberton, "The Mediterranean Fruit Fly." *Jour. Agr. Research*, 3, 1915, pp. 311, 363; 5, 1916, pp. 657, 793; 6, 1916, p. 251. *The Melon Fly*. Bul. 643, Bur, Ent. U. S. Dept. Agr. 1918, *Jour. Agr. Research*, 3, p. 269, 1915.

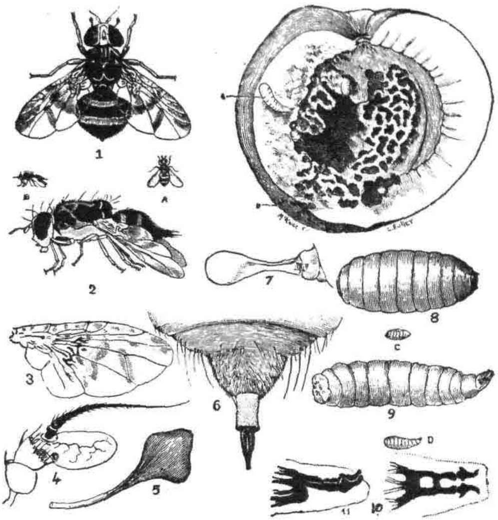

FIG. 483.—The Mediterranean fruit fly, *Ceratitis capitata* (Wied.), and work of maggots in peach. A, maggot; B, holes in fruit where maggots escaped; 1, male; 2, female; A, and B, adults natural size; 3, wing; 4, antenna; 5, clubbed appendage from head of male; 6, ovipositor; 7, halteres; 8, pupa; C, pupa natural size; 9, maggot; D, maggot natural size; 10, and 11, mouth hooks of the maggots. (After Fuller.)

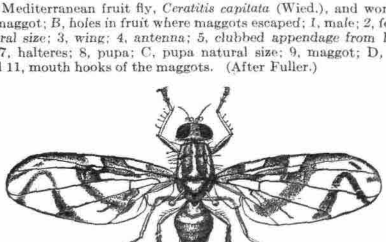

FIG. 484.—The Mexican orange maggot, *Anastrepha ludens* (Loew). Adult female. (After Riley, U. S. Dept. Agr.)

region and also occurring in Northwest India on wild olives; **the melon fly,** *Bactrocera cucurbitæ* (Coq.) (*Dacus*) (Fig. 485), which seriously attacks melons, squashes, tomatoes, string beans, and other vegetables in Hawaii and many Pacific Islands and countries. There are many others all of which are effectively quarantined by the Federal Horticultural Board and every effort is being made by Federal and State authorities to keep these serious pests out of the country. Besides fruits, members of this family produce galls, and mine the leaves of native plants, to which class most of our endemic species belong, with very little known regarding their habits.

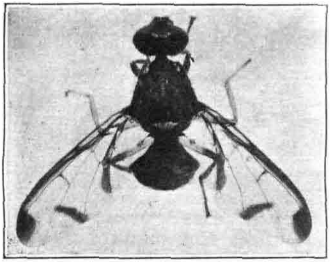

FIG. 485.—The melon fly, *Bactrocera cucurbitæ* (Coq.). (After Maskew.)

Artificial control measures are quite difficult and great stress is being placed on the use of natural enemies. The Lotrionte fruit fly bait is one of the most satisfactory sprays because it is very attractive to the flies, is more effective than arsenical poisons, and does not cause smutting. It consists of syrupy glucose diluted with 2 per cent water and 2 per cent copper sulfate. The treatment for the olive fly consists of a "system of poison traps called 'capannette' or little huts because of their shape. A sheet of tin 14 by 10 inches is bent into a V-shaped gutter which is inverted to form a roof for a bundle of dried olive twigs placed in the hollow and retained there by two galvanized wires. The ends of these are brought through the ridge of the roof and are then wound around the lowest horizontal branch of the olive tree requiring protection. Before fastening it, the twigs should be well wetted with the following mixture: liquid glucose 50 to 60 parts, sodium arsenite 2 parts, boric acid 2 parts, borate of soda 2 parts, all by weight. One trap per tree is required where the tree has few branches and two traps where branches are numerous. The mixture must be re-applied about five times during the season by means of a spray pump, with care to avoid spilling or dropping the mixture on the leaves and branches of the tree."

The sunflower peacock fly, *Strauzia longipennis* Wied. (*Straussia*), is 6 mm. long to the tip of the abdomen. The color is yellow with gray pruinose on the body and a bright orange ovipositor tipped brown. The wings are beautifully marked with yellow serpentine infuscations. The heads of the males bear a tuft of large black spines on the top. The maggots infest the stems of wild and cultivated sunflowers. The distribution includes many parts of the United States. In the west the fly is known in Montana, Wyoming, Colorado, and New Mexico. *S. diffusa* (Snow) also occurs in New Mexico, Washington, and Colorado in the west.

The parsnip leaf miner, *Acidia fratria* (Loew) (*Trypeta liogaster* Thomson),[1] is a small fly but 5 mm. long, of various shades of yellow with greenish

[1] F. H. Chittenden, Bul. 82, pt. 2, Bur. Ent. U. S. Dept. Agr. 1909, p. 9.

abdomen, brilliant green eyes, wings beautifully marked with yellow, and yellow or dark ovipositor. The maggots are pale yellowish, 7 mm. long when mature, and have a large bilobed process at the dorsal end bearing the stigmæ. They make irregular mines extensively on the older lower leaves of cultivated and wild parsnips in various parts of the country. In the west the species is known in Washington and California.

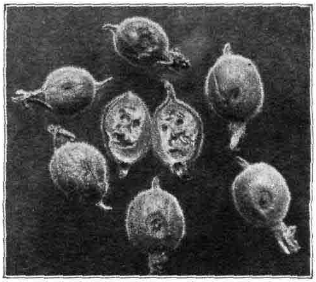

FIG. 486.—Gooseberries showing eggs punctures and work of the maggots of the currant or gooseberry fruit fly, *Epochra canadensis* (Loew).

The currant or gooseberry fruit fly, *Epochra canadensis* (Loew)[1] (Figs. 486, 487), is about the size of the common house fly or 5 mm. long. The color is yellow or orange, with green eyes and fine dark cross-bands on the wings. The eggs are oblong shiny white and 1 mm. long with a small pedicle at the proximal end. They are inserted singly in each fruit in May and June, each fly laying from 100 to 200. The maggots are whitish, subcylindrical, and 7 mm. long when full grown. They feed on the pulp around the seeds and cause complete destruction of the fruit of cultivated and wild currants and gooseberries. At maturity they leave the berries and enter the soil where pupation occurs in an oval yellow puparium two or three inches below the surface, in which condition the winter is passed. The adults emerge from the soil in May and June to mate and lay eggs. There is but a single generation a year. The fly is apparently indigenous to much of North America and occurs throughout the west, being a common pest in British Colum-

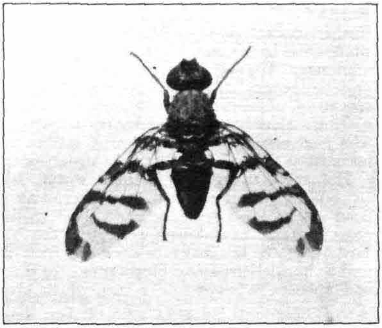

FIG. 487.—The currant or gooseberry fruit fly, *Epochra canadensis* (Loew). Adult male. (After Whitney.)

[1] C. P. Gillette, Bul. 19, Colo. Agr. Exp. Sta. 1892, p. 18.
C. V. Piper and R. W. Doane, Bul. 36, Wash. Agr. Exp. Sta. 1898.
J. H. Paine, *Psyche*, 19, 1912, p. 139.
H. H. P. Severin, Bul. 264, Maine Agr. Exp. Sta. 1917.

bia, Washington, Montana, Oregon, California, and Colorado. *E. rubida* Coq. is a similar species occurring in Colorado and Southern California. There are no satisfactory means of controlling this fly in commercial plantings.

The baccharis gall fly, *Trypeta baccharis* Coq., is 5 mm. long, yellowish brown with brown clouded wings. The larvæ live in irregular oval galls 12 mm. long on the tender stems of baccharis or mule fat in Southern California. *T. notata* Coq. produces slightly woolly spherical galls 9 mm. in diameter on bigelovia in New Mexico.

The white-banded cherry fruit fly, *Rhagoletis cingulata* Loew,[1] is a beautiful, small, shining black fly 4 to 5 mm. long, with head, lateral lines on the thorax, and transverse bands on the abdomen white, the scutellum, tibiæ, and tarsi yellow, and wings with transverse and oblique black markings. The eggs are elongated, 0.8 mm. long, yellowish with a small pedicle at one end. They are inserted in half-ripe cherries, often several in a single fruit, and hatch in from 4 to 6 days. The maggots are 6–7 mm. long and yellowish in color. They infest the ripening fruit. When full grown they go into the ground and pass the winter as cinnamon brown puparia, from which the adults emerge in the spring. There is but a single generation a year. All kinds of sour and sweet cherries are attacked. The insect is a common pest in the east and is reported by Cole and Lovett and by Aldrich from certain counties in Oregon in the west where it infests chiefly late varieties.

The black-bodied cherry fruit fly, *Rhagoletis fausta* O. S. (*R. intrudens* Aldrich),[2] is also an eastern species which is gradually spreading in the northwest and is already established in Montana, Idaho, Washington, and British Columbia. The adults are larger than the preceding species and are further characterized by having the abdomen entirely black without the white cross bands, and by the heavier and differently arranged black wing markings. The species prefers the sour cherry, but apparently infests other varieties as well. *Urophora caurina* (Doane) (*Rhagoletis*) is a black Oregon species of which nothing is known concerning its life habits. According to J. M. Aldrich it has recently been placed in the above genus. *Rhagoletis juglandis* Cresson[3] is a tawny species with black wing bands. The larvæ mine the hull or exocarp of a variety of the English walnut in Arizona.

The apple maggot or railroad worm, *Rhagoletis pomonella* (Walsh)[4] (*R. zephyria* Snow), is a small, shining black fly 5 mm. long, with orange head and greenish eyes, the lateral lines on the thorax, the scutellum, and cross lines on the abdomen white, and the legs dusky and yellow. In the Eastern States the maggots infest the fruit of apples, crabs, and haws, as well as huckleberries and blueberries. In the west it is not a pest to apple and appears to constitute a race which breeds entirely on snowberry.[5]

[1] J. F. Illingworth, Bul. 325, Cornell Agr. Exp. Sta. 1912.

[2] J. M. Aldrich, *Can. Ent.*, 41, 1909, p. 70.
J. F. Illingworth, Bul. 325, Cornell Agr. Exp. Sta. 1912.
L. Cæsar, *45th Rept. Ent. Soc. Ont.*, 1914, p. 107.

[3] E. T. Cresson Jr., *Ent. News*, 31, 1920, p. 65.

[4] W. H. Brittain and C. A. Good, *The Apple Maggot in Nova Scotia.* Bul. 9, N. S. Dept. Agr. 1917.
H. H. P. Severin, *Control of Apple Maggot by Poisoned Bait Spray*, Bul. 251, Maine Agr. Exp. Sta. 1916.

[5] W. Downes, *Can. Ent.*, 51, 1919, p. 2.

This western race is composed of small individual specimens, known to occur in British Columbia, Washington, Oregon, and California.

The dark currant fruit fly, *Rhagoletis ribicola* Doane,[1] is black with the head and its appendages yellow, and with a black blotch on the vertical triangle; the legs yellow with black markings; the thorax with four wide white vittæ; the abdomen with wide white posterior margins on segments two, three, and four; the length of body 3.5 to 4.5 mm. This native species infests wild and cultivated currants and gooseberries much as does *Epochra canadensis* (Loew). It is known in Washington and Idaho and a single specimen was taken at Lake Tahoe, California, by E. P. Van Duzee in 1915.[2]

The bigelovia gall fly, *Eurosta bigeloviæ* Ckll. (Fig. 488), is a small or yellow rufous fly 3 mm. long, with green eyes, spotted wings, and reddish ovipositor. The larvæ produce round galls on the stems of bigelovia. In Colorado these galls are described as being compact, as large as hazelnuts, and covered with white pile. Galls taken in Southern California by the writer were smooth and shining. The species is common to Colorado, New Mexico, Arizona, Utah, and California. *Eurosta solidaginis* (Fitch) makes galls on goldenrod in Colorado, Oregon, and throughout the United States. *Paracantha culta* (Wied.) (*Carphotricha*) infests the heads of thistles in Washington, Idaho, Oregon, California, New Mexico, and Colorado. J. M. Aldrich reports it as ovipositing in the flower heads of cultivated sunflower. It occurs throughout North America.

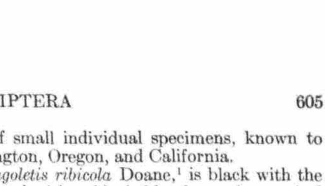

FIG. 488.—The bigelovia gall fly, *Eurosta bigeloviæ* Cockerell. Galls on stems of bigelovia and the adult.

Tephritis finalis (Loew) is yellow and brownish with a shiny black abdomen. It infests the head of *Eriophyllum lanatum* (Pursh.) in Oregon (Cole and Lovett), of balsam root in Washington (Hyslop), and various *Compositæ* (Doane). It also occurs in Idaho, California, Arizona, New Mexico, Texas, and Mexico in the west. *Euaresta æqualis* (Loew) has been reared from seed pods of cockle bur and occurs throughout the United States. It is recorded in Idaho, Oregon, Colorado, and New Mexico in the west.

ORTALIDÆ.[3] Ortalid Flies (Fig. 489).

The droop-winged fly, *Stictomyia longicornis* (Bigot), is a small fly 4 mm. long with spotted drooping wings. It is a very common throughout the cactus areas of Mexico, New Mexico, Arizona, and Southern California. The maggots are scavengers in injured or decayed portions of cactus.

The sugar beet ortalid, *Tetanops aldrichi* Hendel,[4] is 6 mm. long, shining black, with a smoky patch on the costal margin of the wing about one-third the distance from the base to the tip. The flies appear in July and August. The maggots feed on the tap roots of small sugar beet seedlings causing the tissues to turn black at the point of attack, and in many cases killing the plants in Utah. A similar injury to sugar beets in California is reported

[1] R. W. Doane, *Ent. News*, 9, 1898, p. 69.
C. V. Piper and R. W. Doane, Bul. 36, Wash. Agr. Exp. Sta. 1898, p. 3.
[2] H. H. P. Severin, *Mthly. Bul.*, Cal. State Com. Hort., 6, 1917, p. 258.
[3] D. W. Coquillett, *Jour. N. Y. Ent. Soc.*, 8, 1900, p. 21.
[4] I. M. Hawley, *Jour. Econ. Ent.*, 15, 1922, p. 388.

by H. H. P. Severin. Weeds are also infested. The fly occurs in Colorado, Idaho, Oregon, and Canada.

Chrysomyza demandata (Fabr.) is a European and African species which occurs in various parts of North America. The larvæ breed in almost any decaying and fermenting vegetable matter, such as manure, rotting stems of plants, and so forth. C. W. Johnson reports adults reared from decayed berries and grapes in Pennsylvania.[1] C. N. Ainslie found the maggots in the excrement of the corn ear worm, in ears as well as in the decayed stems of corn, and on young date palms in Arizona.[2] The western distribution includes Texas, Arizona, Utah, California, Washington, and Oregon (Cole and Lovett).

The spotted root fly, *Euxesta notata* (Wied.),[3] is a small metallic green or blue fly 3 mm. long, with a black spot near the front margin and another near the tip of each

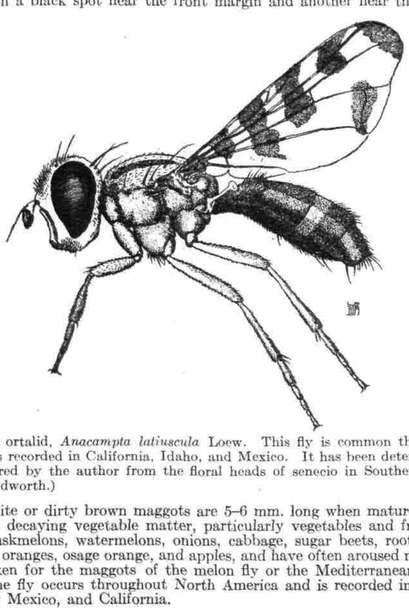

FIG. 489.—The ortalid, *Anacampta latiuscula* Loew. This fly is common throughout the west and is recorded in California, Idaho, and Mexico. It has been determined as the species reared by the author from the floral heads of senecio in Southern California. (After Woodworth.)

wing. The white or dirty brown maggots are 5–6 mm. long when mature. They are to be found in decaying vegetable matter, particularly vegetables and fruits such as cucumbers, muskmelons, watermelons, onions, cabbage, sugar beets, roots of various plants, berries, oranges, osage orange, and apples, and have often aroused much anxiety because mistaken for the maggots of the melon fly or the Mediterranean fruit fly in California. The fly occurs throughout North America and is recorded in the west in Colorado, New Mexico, and California.

PIOPHILIDÆ.[4]

This family consists of small, largely scavenger flies.

The cheese skipper, *Pipohila casei* (Linn), is a small dark bronze or bluish-black fly 2.5 to 4 mm. long, with the face, mouth parts, and antennæ

[1] *Ent. News*, 11, 1900, p. 609.
[2] *Proc. Ent. Soc. Wash.*, 13, 1911, p. 118.
[3] E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 340.
[4] A. L. Melander and A. Spuler, Bul. 143, Wash. Agr. Exp. Sta. 1917.

yellow. The wings usually overlap when at rest. The eggs are slender, slightly curved, tapering towards each end, white, and 0.7 to 0.9 mm. long. They are usually laid singly in the cracks, broken places, or generally over the surface of the food of the white, yellowish, or grayish maggots which when mature are 8 to 10 mm. long. The maggots jump freely which has given rise to the common name. When mature they come to the surface where the cinnamon brown, oval puparia 4 to 6 mm. long are to be found. The fly is cosmopolitan and occurs in all parts of North America. It is a scavenger and the maggots feed in carrion or in ham, bacon, oleomargarine, and cheese, the latter being the common preferred food particularly when overripe or moldy. It is, however, often a serious pest of cured meats. The presence of this pest is due chiefly to poor sanitary methods. Fumigation of the infested rooms and articles with either hydrocyanic acid gas or carbon disulfid is the best method of control.[1]

PSILIDÆ.[2] Rust Flies.

The members of this family are small, slender, shining flies with long antennæ.

The carrot rust fly, *Psila rosæ* (Fabr.), is a small fly 4 mm. long, dark green with black eyes and yellow legs and head, and the body sparsely clothed with yellow hairs. This fly lays its eggs about the crowns of carrots, celery, and parsnips, and the small dark brown maggots burrow into the crown or roots. It is a European species common in eastern and middle North America and reported "as sometimes of economic importance" in Oregon by Cole and Lovett.

EPHYDRIDÆ.[3] Ephydrid Flies.

These are small, mostly brown, gray, or blackish flies often present in countless numbers about fresh, salt, and alkaline water in which the peculiar larvæ live. A few live in the stems of aquatic plants and some in the sap of trees. Some European species are serious pests to grains and grasses.

The petroleum fly, *Psilopa petrolei* Coq.,[4] is one of the most interesting insects because of the adaptations of the larvæ which enable them to live in crude oil or petroleum which naturally oozes out of the ground and forms little pools. The adults are small, 2 mm. long, polished black with pale halteres, and densely hairy eyes. They are to be found around crude oil in the natural fields or about refineries and oil tank farms. The larvæ are 7–10 mm. long, elongate-oval, rather transparent, 12-segmented, roundly acute at the anterior end, and with four processes at the posterior end which project backwards, the two on the bottom, knob-like, and the two on the dorsum, similar with black heavily chitinized tips. Near the apices of the upper projections are four fan-like groups of cilia which keep the stigmata above the oil surface when taking air. The dorsal tubes are telescoped to protect the breathing organs when submerged. The larvæ live freely but only in small pools of oil, and feed on the oil alone or on small particles contained therein. Pupation occurs about the edges of the pools and not in

[1] E. R. deOng and C. L. Roadhouse, Bul. 343, Cal. Agr. Exp. Sta. 1922.

[2] A. L. Melander, "Synopsis of *Psilidæ*." *Psyche*, 27, 1920, p. 91.

[3] B. J. Jones, "Cat. *Ephydridæ* with Biology and Desc. of N. Spp." *Univ. Cal. Pub. Tech. Bul. Ent.*, 1, 1906, p. 153.

J. M. Aldrich, "Biology of Western *Ephydra*." *Jour. N. Y. Ent. Soc.*, 20, 1912, pp. 77, 99.

E. T. Cresson, Jr., "Studies in the American *Ephydridæ*." *Trans. Am. Ent. Soc.*, 42, 1916, p. 101.

[4] D. W. Coquillett, *Can. Ent.*, 31, 1899, p. 8. Orig. desc.

L. O. Howard, *Scientific Am.*, 80, 1899, p. 75.

D. L. Crawford, *P. C. Jour. Ent.*, 4, 1912, p. 687.

the oil. The distribution covers much of California where there are oil fields and also the refineries and tank farms in the San Francisco Bay region.

The rice leaf miner, *Hydrellia scapularis* Loew, was collected during June, 1922, by E. R. deOng who found the floating leaves of inundated rice completely mined and the old burrows still containing pupæ. The larvæ are white or grayish, the pupæ brown, and the small adult flies blackish. The infestation was limited to a few experimental plots at Briggs, California. The species occurs in various parts of North America and is known in Alaska, British Columbia, Oregon, and California in the west.

The mantis fly, *Ochthera*[1] *mantis* (De Geer), is 4–5 mm. long, brownish black, with metallic thorax and raptorial fore legs in which the femur is greatly enlarged, and the tibiæ curved and armed with a strong apical spine somewhat like a mantis. The adults are supposed to be predaceous. The species is European and widely distributed over the United States, being known in Wyoming, Oregon, and California.

Members of the genus *Ephydra* are mostly found about brackish sea water or salt or alkaline ponds and lakes in desert areas. The larvæ are aquatic and are provided with a long usually branched anal tube which serves as a tracheal gill at the posterior end, and with many pairs of non-articulating false legs, which are provided with curved hooks (Fig. 490). The puparia are composed of the last larval skin. They are attached to the bottom or float to the surface of the water and are often cast up on the beaches

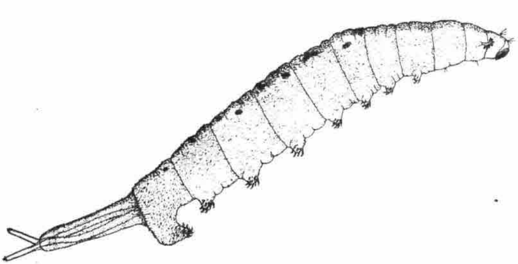

FIG. 490.—Larva of the salt marsh fly, *Ephydra millbræ* Jones. (After B. J. Jones.)

or about the edges of lakes and ponds in great masses. *Ephydra auripes* Aldrich is 3.6 mm. long, opaque green and metallic blue, the legs marked yellow. The larvæ live in brackish water near the Great Salt Lake, Utah. *Ephydra gracilis* Packard is 2.3 to 3.5 mm. long, opaque gray, paler beneath and with a slight green tinge above, and bright green legs marked with yellow. The larvæ are somewhat transparent white, 10.6 mm. long, the anal tube which has a basal and apical pair of forks, is from the base to the terminal fork 4.9 mm. long, each of the prongs of the terminal fork 1.6 mm., and each basal fork 2 mm. in length. They have 8 pairs of long prolegs. The larvæ live suspended everywhere in the open water of Great Salt Lake, Utah, and Salton Sea, in salt water in San Francisco and adjacent to the Pacific Ocean at Laguna Beach, California. The fly was introduced from Great Salt Lake into San Francisco Bay by railroad trains after the building of the cutoff at the Lake: J. M. Aldrich, *Psyche*, 25, p. 30, 1918. The adults often swarm in great numbers on the surface of the water and along the shores. *Ephydra hians* Say (Fig. 491) is 3.2 to 5.6 mm. long, black or wholly opaque gray, with shining dark green front, and the abdomen with a greenish ground color. The larvæ are 12 mm. long, whitish, with a wide shagreen pigmented band the full length of the dorsum, 8 pairs of prolegs, the last pair of which is reversed so as to enable the larva to grasp a solid object for attachment. The anal tube is variable in length, but considerably shorter than that of the preceding species, and does not have

[1] W. M. Wheeler, "The genus *Ochthera*." *Ent. News*, 7, 1896, p. 121.

the basal fork. The larvæ live near the bottoms of salt or alkaline lakes and are attached or wriggle about, but do not come to the surface. The pupæ are normally attached to rocks or some other object at the bottom. Storms frequently detach immense numbers which float and are carried to the shores where they are thrown up in great heaps. According to J. M. Aldrich, the Indians in early days collected, dried, and after rubbing off the skins by hand, prepared a food called "Koo-chah-bie"[1] by the Pah-Ute Indians. The adults are abundant at the edges of the water and enter the water from a rock or other solid object, enveloped in a globule of air. The small, white, slightly curved smooth eggs, 0.8 mm. long, are laid in this manner or dropped directly into the water. The present known distribution includes Soap Lake and Lake Como, Washington; Albert Lake, Oregon; Borax Pond near Clear Lake, Mono Lake, Owens Lake, Borax Lake, and East Lake, California; Soda Lakes, Pyramid Lake and Lagoon south in Nevada; Great Salt Lake, Utah; Wyoming, Nebraska, Minnesota, and Mexico. In examining some of the puparia collected on the shores of Mono Lake by W. B. Herms, the writer found some parasites which had issued in captivity. The species has been determined by A. B. Gahan as *Urolepis rufipes* (Ashm.). *Ephydra millbræ* Jones (Fig. 490) is a bluish green fly 3.75 to 4 mm. long, which fairly swarms over the surface of brackish water pools, particularly in the San Francisco Bay region, but also in Southern California and in Washington. These flies feed chiefly on dead animal matter floating on the water. The eggs are white, obovate, the smaller end sparsely hairy. They are attached by the larger end to bits of floating vegetation or puparia. The larvæ are 10–12 mm. long, dirty white, pubescent, small clusters of black hairs on dorsum of the last six segments, 8 pairs of false legs armed with curved hooks, rudimentary antennæ, a pair of fan-like spiracles or gills on the segment just back of the head, and with a semitransparent anal tube 3.5 mm. long which is forked near the end. The larvæ occur on the bottoms of the pools. The puparia are brownish black, 12 mm. long, and are attached to bits of floating vegetation by the last abdominal segment, with the anterior end into the water and the siphon or anal tube protruding above the surface. In July, 1924, J. F. Lamiman observed adults, which were blown in from San Francisco Bay, settling in such great numbers on drying apricots on trays at Mountain View, California, so as to completely cover the fruit, causing serious damage by spotting with excrement. *Ephydra subopaca* Loew is 4–5 mm. long, whitish to yellowish with greenish cast to the abdomen, and a metallic green front. The larvæ are much like those of *E. hians* Say, but lack the dorsal pigmentation, being almost white with the tips of the anal fork black. They live in slightly saline water, not occurring in dense water as the two preceding species. The fly occurs in Box Elder Lake, Garfield, and Promontory Point, Utah; Market Lake, Idaho; overflow of Hazen, Winnemucca Lake, and Walker Lake, Nevada; seepage of Mono Lake, California; and Soap Lake and Grand Coulee, Washington. Adults are reported from Central and Eastern States as well. *E. viridis* (Hine) is 6.2 mm. in length and is a large, robust, dull green fly with yellow knees. The larvæ live in the salt marshes of the San Francisco Bay region, California. *Scatella intermedia* Cresson, Jr., is 3 mm. long, black with shining brown abdomen, the entire body more or less pruinose, and the wings with five blackish spots. It also occurs in the salt marshes of the San Francisco Bay region, but nothing is known concerning the larval habits.

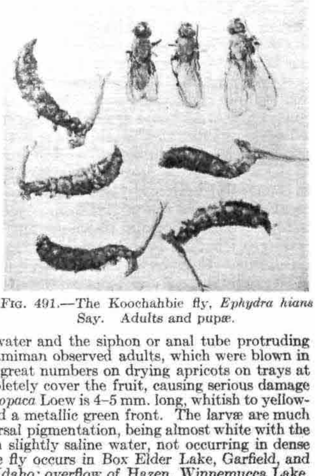

FIG. 491.—The Koochahbie fly, *Ephydra hians* Say. Adults and pupæ.

[1] According to Dr. Aldrich the Modoc and Pitt River Indians applied the name Ha-lib-wah to a leptid fly, *Atherix* sp., "but after the flies were prepared for use as food, the product was called Koo-chah-bie." (*Ent. News*, 23, 1912, p. 159.)

OSCINIDÆ or CHLOROPIDÆ. Frit Flies, Grass Stem Maggots.

The wheat stem maggot, *Meromyza americana* Fitch,[1] is a small slender yellowish green fly, 1.5 mm. long, with three broken dorsal stripes, and the hind femora greatly enlarged. The minute eggs are glistening white and are laid in the fall on the stems above or beneath the sheaths or on the edges of the leaves. The pale greenish maggots which are 6 mm. long, mine down the stem killing the central shoot of young plants and stunting old plants and preventing proper development of the heads, thus causing what is known as "white heads" in wheat. The winter is passed in the larval stage in the growing stems and pupation occurs in the spring, adults emerging in May and June. The progeny of the spring brood mature in August and the next brood in September, making three broods a year. The maggot is specially serious to wheat, but also attacks wild, ornamental and lawn grasses, barley, oats, rye, timothy, and so forth. The insect is distributed generally throughout much of North America and is known in Montana, British Columbia, Washington, Oregon, California, and New Mexico in the west. The mite, *Pediculoides ventricosus* (Newport), often kills many of the larvæ. Wild grasses and volunteer grain are the chief distributors of this pest and should be eliminated as a control measure. Burning straw and stubble is also effective. *Meromyza punctifer* Becker appears to be the commonest wheat and grass infesting species in the west and attacks spring wheat in Oregon and Washington, but it is chiefly of local importance and seldom serious, although Cole and Lovett reported one per cent or more of the wheat heads destroyed in the Yakima Valley, Washington, in 1919. It occurs in Idaho and California also. In California the writer has taken great numbers of the adults from bluegrass lawns. *M. nigriventris* Macq. is reported as injurious to wheat by R. A. Cooley in Montana. *Chlorops graminea* Coq. has been reared from gall-like swellings on grass in Southern California. *C. proxima* Say has been reared from between blades of wheat in the middle west and from swellings on the stems of wild rye in Central California.

The frit fly, *Oscinis frit* (Linn.),[2] is a very important economic species in Europe where it causes great losses to wheat and other cereals. The adults are 1 to 2 mm. long, black, with more or less shining dorsum, yellow halteres, and our western forms with entirely black legs or black with yellow markings. The eggs are pure white, 0.7 mm. long, with finely ridged surface. The mature larvæ are 3 mm. long, yellow, with black curved mouth hooks and anterior and posterior spiracles. The puparia are first yellow, then dark brown, and 2.7 mm. long. According to Aldrich, four broods have been reared during a year in the middle west while European writers report three broods in Europe. The winter is passed in the larval stage in winter grains or grasses. Adults of the first summer brood emerge from about the middle of June to the middle of July; the second summer brood from July 15 to July 26; the third summer brood from August 10 to August 28; and the fourth brood, September 28 to October 3. The average life cycle from adult to adult varies from 21 to 58 days. The hosts plants include wheat, oats, barley, emmer, rye, corn, timothy, sedge, lawn grasses, and many wild grasses. The eggs are laid on the leaves of the young

[1] F. M. Webster, Bul. 42, Bur. Ent. U. S. Dept. Agr. 1903, p. 43.

[2] J. M. Aldrich, *Jour. Agr. Research*, 18, p. 451, 1920.

plants and on the sheaths enclosing the older plants in summer, or on the heads and panicles of grains and grasses. As many as ten maggots may occur in a single plant. The spring and fall larvæ live in the young stems eating the central leaves and shoots which are eventually killed, causing the plant to send out side shoots. Summer larvæ live in the heads or panicles or in the stems. In autumn and spring the larvæ pupate under the sheaths of the outer leaves, while the summer larvæ pupate among the leaves surrounding the hidden heads, or in the heads, or between the husk and the grain where the larvæ have been feeding. Aldrich reports this European species throughout North America and in every State of the United States. In California the writer has taken it in lawn sweepings. Little is known regarding its attacks on cereals in the west. *Oscinis sulphurhalterata* Endl. has been reared in Oregon from cones of lowland fir by Chamberlin (Cole and Lovett). *Siphonella conicola* (Greene)[1] (*Madiza*) has also been reared from cones of lowland fir in Oregon and California. The following western species have been reared from grasses: *Elachiptera planicollis* Becker in Idaho; *Dicræus incongruus* Aldrich in Montana, Idaho, and Utah; *Lasiosina canadensis* Aldrich in Montana, Idaho, Washington, and Wyoming.

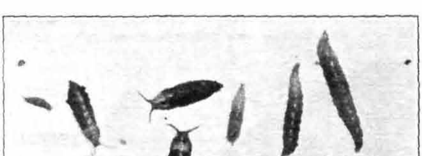

FIG. 492.—Larvæ and pupæ of the pomace fly, *Drosophila ampelophila* Loew.

Among the predaceous forms are *Chloropisca glabra* (Meig.),[2] the larvæ of which are 6.5 mm. long, white, and to be found about the roots of plants feeding on root aphis, particularly the beet root aphis, *Pemphigus betæ* Doane, in California, New Mexico, and Montana. It is widespread in North America and Europe. *Oscinis darlingtoniæ* Jones [3] is a California species, the larvæ of which have been found feeding on dead insects captured in the leaves of the California pitcher plant. *Gaurax araneæ* Coq. has been reared from the egg sac of the spider, *Argiope riparia* Hentz, in Southern California and is thought to be a scavenger.

DROSOPHILIDÆ. Pomace Flies, Vinegar Flies.

The pomace fly, *Drosophila ampelophila* Loew (Fig. 492), is a small light brown or orange-yellow fly about 3 mm. long and famed the country over as a subject of experiments in genetics because of its ability to breed rapidly in confinement. The eggs are oblong, very minute with reticulated surface, and two long appendages as long as the egg. The maggots are dusky or whitish and 7 mm. long. The puparia are slightly

[1] C. T. Greene, *Proc. Ent., Soc. Wash.*, 20, 1918, p. 69.
[2] J. R. Parker, *Jour. Econ. Ent.*, 11, 1918, p. 368.
[3] F. M. Jones, *Ent. News*, 27, 1916, p. 389.

shorter, but more robust and with two horn-like respiratory tubes. The color is yellow or brown with a pale band at the bases of the tubes. The larvæ breed chiefly in decaying and fermenting fruits and fruit products, but have been reared from excrement and decayed vegetable and animal matter. Fruits, vinegar, jellies, pickles, and so forth, attract the flies. Fermenting bananas are usually used for breeding purposes. The maggots often become very abundant in figs souring on the trees after early rains. While they may be taken in connection with the work of other fruit insects like the larvæ of the codling moth, they have never been known to initiate attacks on sound fruits. This fly is common in the Mediterranean region and throughout North America. *Drosophila buscki* Coq. is smaller but much the same color with fine dark lines across the abdomen. It has been reared from decaying vegetables and fruits such as bananas, squash, potatoes, mushrooms, and so forth. Cole and Lovett record it as bred by L. P. Rockwood from clover heads in Oregon. It is common in California and reported from several places in the United States. *Drosophila repleta* Wollaston is larger than the two preceding species and of striking grayish color with the abdomen marked black and yellow on the dorsum, with a wide, continuous, median, longitudinal yellow stripe, and each segment with wide yellow base and narrow apical margin of the same color. Some forms are almost black. It breeds in fungi and occurs in South America ranging north into Mexico, California, and the Southern States to New York.[1]

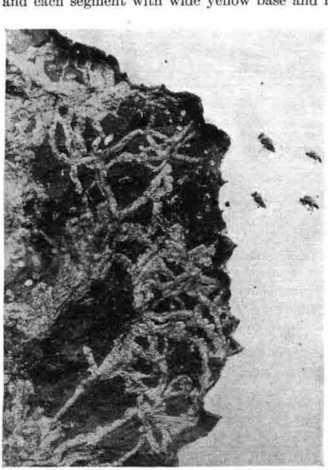

FIG. 493.—The chrysanthemum leaf miner, *Phytomyza chrysanthemi* Kowarz, and mines in a cineraria leaf.

PHYTOMYZIDÆ.[2]

The members of this family are small leaf-mining insects closely related to *Agromyzidæ*.

The wild parsnip leaf miner, *Phytomyza albiceps* Meigen (*P. genualis* Loew), is a very small black or metallic blue fly 2.3 mm. long, with the front and cheeks, bases of the wings, the bands around the last abdominal segment, and the tibiæ yellow. The larvæ are whitish and the puparia black with two short horn-like respiratory organs at the smaller end. Pupation occurs in the soil. The larvæ completely mine the leaves of the giant wild parsnip and columbines at Berkeley, California. It is a European species generally distributed throughout the United States and is also known in Oregon, Washington, and Idaho in the west.

The chrysanthemum leaf miner, *Phytomyza chrysanthemi* Kowarz (Fig. 493), is 2 mm. long, black, with the face, halteres, portions of the legs, and the hind margin of each abdominal segment yellow. The larvæ are pale yellow with black mouth hooks. They extensively mine the leaves and petioles of chrysanthemums, cinerarias, eupatorium, marguerite, daisies, Shasta daisies, sow thistles, and other

[1] F. Knab, *Psyche*, 19, 1912, p. 106.

[2] A. L. Melander, "Table of Species of *Phytomyza*." *Jour. N. Y. Ent. Soc.*, 21, 1913, p. 269.

Compositæ, and are often quite injurious. Pupation occurs within the mines. The species occurs in various parts of the United States and in California, Oregon, and British Columbia in the west. The maggots are killed in the mines by spraying with 1 part of 40 per cent nicotine sulfate to 400 to 600 parts of water.

The holly leaf miner, *Phytomyza ilicicola* Loew (Fig. 494), mines the leaves of American and English holly and occurs in Alaska, Washington, Idaho, Oregon, and California. *P. obscurella* Fallén mines the leaves of lupine in California and also occurs in Oregon, Washington, and Idaho.

FIG. 494.—Mines of the holly leaf miner, *Phytomyza ilicicola* Loew, on leaf of English holly.

AGROMYZIDÆ [1] Leaf Miners.

The serpentine leaf miner, *Agromyza scutellata* Fallén (*A. pusilla* Meigen),[2] is 2 mm. long, black, with much of the head, parts of the thorax, legs, and abdomen, the halteres and scutellum yellow. The minute white eggs are laid just under the epidermis of the leaf tissues and hatch in 4–6 days. The maggots are yellow with black mouth hooks and when full grown are 3–4 mm. long. They make long winding mines under the epidermis of the leaves of alfalfa, beans, garden and sugar beets, cabbage, burr clover, red clover, white clover, sweet clover, cotton, cowpeas, smooth rock cress, fenugreek, malva, milkweed, horse mint, hedge mustard, nasturtium, sweet pea, pepper, plantain, potato, radish, rape, spinach, tobacco, turnip, vetch, and watermelon. Pupation occurs in the mines or in the ground in the oval shining brown puparia. The life cycle during the summer requires about 23 days. There are from three to five generations a year. This miner is most abundant and injurious in the Southwestern States of New Mexico, Arizona, and Southern California. It is common throughout California, Oregon, Washington, Idaho, Wyoming, Utah, Colorado, and the United States in general. Because of the numerous parasites, the leaf miner is not a generally serious pest, but is sporadic in its attacks. The cutting of forage crops and deep plowing of the land after the harvest of cultivated crops aid greatly in reducing the numbers. Cole and Lovett record the variety *orbona* Meigen mining lupine leaves, and the variety *variegata* Meigen in Oregon. The former also occurs in Washington and Idaho and the latter in Washington and California.

Agromyza parvicornis Loew is an eastern species which mines the leaves of corn and ranges west into Utah. Many of the parasites listed above have also been reared from

[1] A. L. Melander, *Jour. N. Y. Ent. Soc.*, 21, 1913, p. 251.
J. R. Malloch, *Ann. Ent. Soc. Am.*, 6, 1913, p. 269. *Proc. U. S. Nat. Mus.*, 46, 1914, p. 127.
[2] F. M. Webster and T. H. Parks, *Jour. Agr. Research*, 1, 1913, p. 59.
J. M. Aldrich, *Psyche* 25, 1918, p. 33.

it. *Agromyza æniventris* Fallén has been reared from the roots of locoweed, the stems of ragweed, and the leaves of clover and garden peas in Colorado. It also occurs in New Mexico, California, Oregon, Washington, and Idaho. *Agromyza coquilletti* Malloch has been reared from the mines in the leaves of oats, and in wild grasses and oats in Colorado, wheat in Utah, and oats in Idaho. **The strawberry leaf miner,** *Agromyza fragariæ* Malloch, is shining black and 1.5 to 2 mm. long. It has been reared from strawberry leaves in Eldorado County, California. **The alfalfa stem miner,** *Agromyza gibsoni* Malloch, is a stem borer of alfalfa in Arizona. *Agromyza jucunda* Van der Wulp mines the leaves of asters, cocklebur, ericameria, goldenrod, malva, sunflower, verbena, and so on, in California and the east. *A. laterella* Zett. has been reared from mines in leaves of wild and cultivated iris at Berkeley, California, by W. W. Jones. The larvæ of *Agromyza pruinosa* Coq. have been reported by J. R. Malloch [1] as mining the cambium of river or red birch in Colorado. *Agromyza setosa* Loew mines the leaves of chrysanthemum and wild rice (*Zizania*) in the east and strawberry in Placer County, California.[2] It also occurs in New Mexico. *Agromyza virens* Loew mines the stems of white clover, ragweed, and coneflower, and occurs in the east and in Arizona and California in the west. *Agromyza websteri* [3] Malloch produces small stem galls usually at the bases of the buds of the pink flowering wistaria in California, and *A. schineri* (Giraud) makes similar galls on poplar in Colorado.

The asparagus miner, *Agromyza simplex* Loew [4] (Fig. 495), is a small metallic black fly 2 mm. long. The small white maggots mine the seed

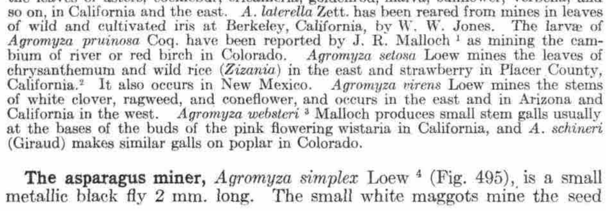

FIG. 495.—The asparagus miner, *Agromyza simplex* Loew. Adult flies at the left, greatly enlarged. Immature forms at right as follows: a, larva or maggot; b, thoracic spiracles and c, anal spiracles of larva; d, side view and e, dorsal view of puparium; f, section of asparagus stalk showing injury caused by the maggots, and section removed to show natural location of the puparia. (After Chittenden, U. S. Dept. Agr.)

stalks of cultivated asparagus, particularly near the ground, but the mines may extend far up into the branches. Although the mines practically cover the entire surface of the stalks, little damage in commercial plantings appears to result from their attacks. The stalks are, however, occasionally killed. Pupation occurs in the mines and the very dark brown puparia are often readily visible through the thin cell walls. This is a European fly now found in many parts of the United States, well distributed, and often abundant in the asparagus fields of the Sacramento and San Joaquin River delta region of California, as recently worked out by F. H. Wymore. Cutting and burning the stalks and winter flooding of the fields effectively control the insect.

[1] *Can. Ent.*, 50, 1918, p. 316.
[2] D. W. Coquillett, Bul. 10, n. s. Div. Ent. U. S. Dept. Agr. 1898, p. 78.
[3] E. O. Essig, *Inj. and Ben, Ins. Cal.*, 2d ed. 1915, p. 347.
[4] F. H. Chittenden, Bul. 66, pt. 1, Bur. Ent. U. S. Dept. Agr. 1907.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed. 1915, p. 346.

The dipterous parasite of the cottony cushion scale, *Cryptochætum iceryæ* (Williston) (*C. monophlebi* Skuse, *Lestophonus*),[1] (Figs. 496–498), was one of the natural enemies of *Icerya purchasi* Mask., introduced by F. S.

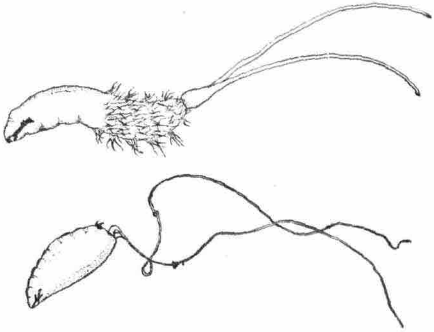

FIG. 496.—Larvæ of *Cryptochætum iceryæ* (Will.). Young above and mature form below. (After Smith and Compere.)

Crawford and Albert Koebele from Australia into California in 1888–9. The adults are 1.5 mm. long, the head and thorax metallic dark blue, and the abdomen iridescent green. They are rather slow in movement, crawling slowly over the cottony cushion scale inserting one to several minute, oblong, oval, smooth, pearly white eggs preferably in the half grown hosts. It is thought that a single female may lay as many as 200 eggs. The young larvæ are curious, semitransparent elongated maggots with black mouth hooks, the anterior half of the body bare, the posterior half ciliated and with two long tail-like processes often twice the length of the body. The full-grown larvæ are quite different. The body becomes pear-shaped with two horn-like tracheæ and the tail-like processes extended to four or five times the length of the body. The color becomes reddish from the contents in the alimentary canal. The larvæ live freely within the body cavity of the

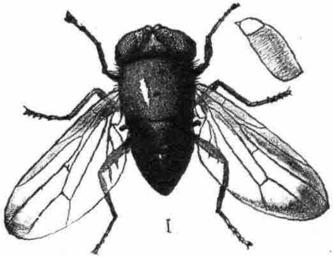

FIG. 497.—Adult and egg of *Cryptochætum iceryæ* (Will.). (After Williston.)

[1] F. Knab, *Insecutor Inscit. Menst.* 2, 1914, p. 33.
H. S. Smith, Life History. *Mthly. Bul.*, Cal. State Com. Hort., 5, 1916, p. 384.

host feeding on the body fluids and apparently not seriously inconveniencing it; upon reaching maturity, however, the host is eventually killed. Several larvæ may occur in a single scale insect. Pupation occurs within the dead body of the host. The puparia are yellow or reddish brown, oval, 2 mm. long, with two horn-like projections. There are five or six generations a year. This parasite is often the most important natural check on the cottony cushion scale, but because of its small size and the concealed manner of attack, it has not been given due credit for its efficiency. In the San Francisco Bay region it persists where the vedalia has long since passed away and keeps the scale insect under almost perfect control. Practically every lot of the scale sent to the University for examination shows the work of the fly and it is with great difficulty that living specimens of this once

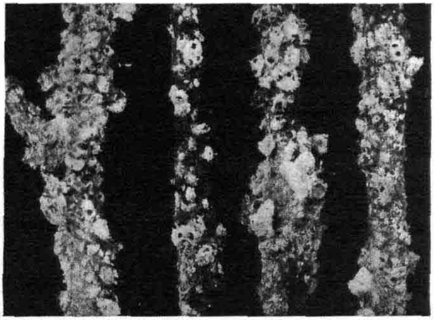

FIG. 498.—Immature stages of the cottony cushion scale, *Icerya purchasi* Mask., showing exit holes of the adults of *Cryptochætum iceryæ* (Will.).

common and abundant scale insect can be secured for student study. In Southern California too this parasite has done much of the work claimed for the vedalia. There has been considerable confusion as to the exact identity of this fly. In a letter dated March 4, 1922, and addressed to the writer, J. M. Aldrich remarks concerning *Cryptochætum iceryæ* (Williston), which he believes to be the one occurring in California: "Both Skuse and Knab were misled by the figure accompanying Williston's first description. Williston had nothing to do with this figure and published afterward a corrected figure of the venation in his species. He distinctly stated that the wings were 'short and broad,' which agrees with his figure published later, but not at all with the figure published with his original description. So I believe you are justified in continuing to call your species '*iceryæ*'."

The wheat sheath stem maggot, *Cerodonta femoralis* Meigen,[1] is a minute

[1] Also spelled *Cerodontha*.

P. Luginbill and T. D. Urbahns, Bul. 432, *Prof. Paper*, Bur. Ent., U. S. Dept. Agr. 1916.

H. L. Seamans, *Jour. Agr. Research*, 9, 1917, p. 17.

J. M. Aldrich, *Ann. Ent. Soc. Am.*, 11, 1918, p. 63.

black and yellowish fly 2 to 2.5 mm. long. There are two color phases, one *C. dorsalis* Loew, occurring east of the Rockies and a darker western form, *C. femoralis* Meig., which occurs west of these mountains. The minute eggs are laid on the leaves of native grasses, oats, timothy, wheat, and so forth, and hatch in about a week. The larvæ mine down the leaves towards the stalk, ending in the leaf sheaths at the crown or the first node. From here they work up and down the sheath or around the stalk causing it to wither and die. The mines are distinct and almost straight. The first adults appear about the middle of May and lay eggs for about a month. There are three broods a year. The western form is reported injurious to wheat in Montana, and common and more or less destructive in Idaho, Wyoming, Colorado, New Mexico, California, Nevada, Oregon, Utah, Washington, and British Columbia. Clean culture and burning the stubble give control.

OCHTHIPHILIDÆ.

These small flies greatly resemble those of the preceding family but are pruinose or gray and the larvæ are predaceous rather than plant feeders.

Leucopis bella Loew is a very small silvery gray fly with the first abdominal segment black except the margins, and black spots on other segments, cinereous antennæ, whitish wings, and yellow front tarsi. The eggs are pure white, oblong-oval and sculptured with longitudinal ridges. The larvæ are yellowish white and creep by looping. They are to be found in the cottony egg masses of many mealybugs and other scales. The puparia are brown or blackish and have two long spiracular tubes. The winter is passed in the pupal stage. There are a number of generations a year. Among the hosts are cottony cushion scale, citrus mealybug, Baker's mealybug, citrophilus mealybug, Eriogonum mealybug, and the cottony cochineal scales in California. The species is also known in Colorado and Eastern States. *Leucopis bellula* Williston is similar to the above but has the base of the first abdominal segment brown, spots on the abdomen, and only the base of the antennæ cinereous. The larvæ feed on mealybugs, cottony cochineal scale, and orthezia in New Mexico, Texas, California, Idaho, and Mexico. *Leucopis griseola* Fallén and *L. nigricornis* Egger are often abundant, the larvæ being efficient destroyers of aphis on the leaves and stems of plants. The writer found millions of larvæ of the former feeding on the melon aphis on cantaloupes in Southern California in July, 1921. So abundant were they that they finally controlled the aphis completely. The former occurs in California, Oregon, Washington, and Idaho; and the latter in Texas, New Mexico, Arizona, and California. Both are European and also occur in the east. *Leucopis simplex* Loew is widely distributed throughout the United States and ranges west into Washington and Arizona. The larvæ have been observed feeding on the aërial forms of the grape phylloxera and on *Chermes* sp., in the east.

PUPIPARA [1] (Suborder)

Louse Flies, Tick Flies, Bat Flies, Flat Flies

These are flies usually with a more or less leathery integument and usually with the coxæ of the legs widely separated; as a rule they are strongly

[1] G. F. Ferris prepared most of the manuscript of this order and furnished three original illustrations.

flattened or in a few cases strongly compressed in form. The abdomen of the female is always largely membranous and consequently capable of great distention, the abdominal segmentation as a result being very obscure. This is generally true of the males also, except in one family, the *Nycteribiidæ*, where the male has the abdomen very distinctly segmented and differing very greatly from that of the female. The wings may be

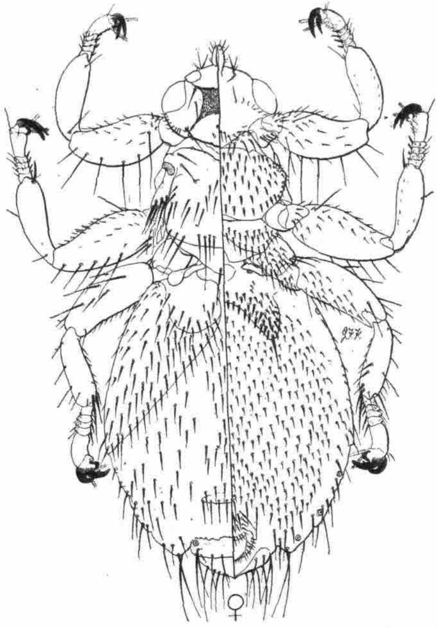

FIG. 499.—The deer tick fly, *Lipoptena depressa* (Say). Dorsal and ventral aspects. (After Ferris.)

entirely absent, they may show various degrees of reduction, or they may be entirely functional. The halteres are sometimes quite small and concealed in a pit but are present in all the forms but one. In the common sheep tick, *Melophagus ovinus* (Linn.) (Fig. 500), the halteres are entirely absent, but this is perhaps the only fly in which this happens.

The species are all blood suckers and live as ectoparasites on birds and mammals. Two of the families are confined to bats. The life histories of

but few of the species are definitely known but in these, and probably in all, the larvæ are produced one at a time and are retained in the body of the female, where they are nourished by special glands, until they are ready to pupate. The larvæ are almost spherical objects and when first extruded are white but rapidly turn brown or black as pupation takes place. They have no mouth parts and the tracheal system is very peculiar. In the only larva of a Streblid that has been described in detail, there are three large spiracles; in the larvæ of the *Nycteribiidæ* there are four small spiracles; in the *Hippoboscidæ* various conditions exist. In the sheep tick there are three pairs of small spiracles at the apex of the body. In other forms the posterior end of the body is formed into a large, heavily chitinized plate, which is probably the much enlarged and fused stigmatic plate, which is pierced by numerous minute pores that connect with tracheal branches.

KEY TO FAMILIES

1. Head rising apparently from behind the front coxæ and capable of being folded back upon the dorsum; thorax greatly flattened and expanded; compound eyes, if present, represented at the most by two facets; wings always absent. Found only on bats. (Bat Tick Flies.) .... **Nycteribiidæ** p. 623
   Head not apparently rising from behind the front coxæ; sometimes flattened but never with the thorax strongly flattened and expanded 2

2. Palpi broader than long, projecting leaf-like in front of the head; wings absent, vestigial or fully developed, never with the veins crowded toward the costal border. Found only on bats. (Bat Flies.) .... **Streblidæ** p. 623
   Palpi slender and elongate, more or less sheathing the proboscis; wings vestigial in various degrees or fully developed, sometimes caducuous, with the major veins crowded toward the costal border. Parasitic on birds and mammals other than bats. (Louse Flies, Flat Flies.) .... **Hippoboscidæ**

HIPPOBOSCIDÆ.[1] Louse Flies, Flat Flies.

These are tough, usually flattened flies with the coxæ as a rule widely separated and with the wings ranging in development from minute tubercles as in the sheep tick, *Melophagus ovinus* (Linn.) (Fig. 500), to fully functional parts. Two species of **deer tick flies** occur upon deer in California. They are distinguished from each other by the fact that one, *Lipoptena depressa* (Say) (Fig. 499), has upon the dorsum of the abdomen two lines, diverging from the base in the form of a V, while in the other species, *Lipoptena subulata* (Coq.), these lines are absent. In these two species the wings are present at the time of emergence from the pupa but are broken off when a host is found.

The sheep tick, *Melophagus ovinus* (Linn.) (Fig. 500), is about 6 mm. long and occurs very commonly on sheep. The puparia are glued to the wool by the female and are often wrongly thought to be eggs. The adults emerge from the pupa in from 19 to 24 days. Like the other members of the group they are blood suckers, irritate the sheep, and soil the wool with their excrement and pupæ. The species is cosmopolitan. Dipping with coal-tar-creosote as recommended for the true lice and scabies kills this insect. The species is remarkable for the fact that while vestiges of

[1] M. H. Swenk, "N. A. *Hippoboscidæ*." *Jour. N. Y. Ent. Soc.*, 24, p. 126, 1916.
G. F. Ferris and F. R. Cole, "Contrib. to Knowledge of *Hippoboscidæ*." *Parasitology*, 14, p. 178, 1922.
J. M. Aldrich, "Notes on *Hippoboscidæ*." *Insecutor Inscit. Menstr.*, 11, p. 75, 1923.

FIG. 500.—The sheep tick, *Melophagus ovinus* (Linn.). (Photo furnished by S. B. Doten.)

FIG. 501.—*Ornithoica confluenta* (Say). Dorsal and ventral aspects. (Drawing by G. F. Ferris.)

the wings, in the form of minute tubercles, are retained, the halteres are entirely lacking. It is one of the very few flies, if indeed it be not the only one, in which the halteres are absent. A subspecies, *M. ovinus montanus*

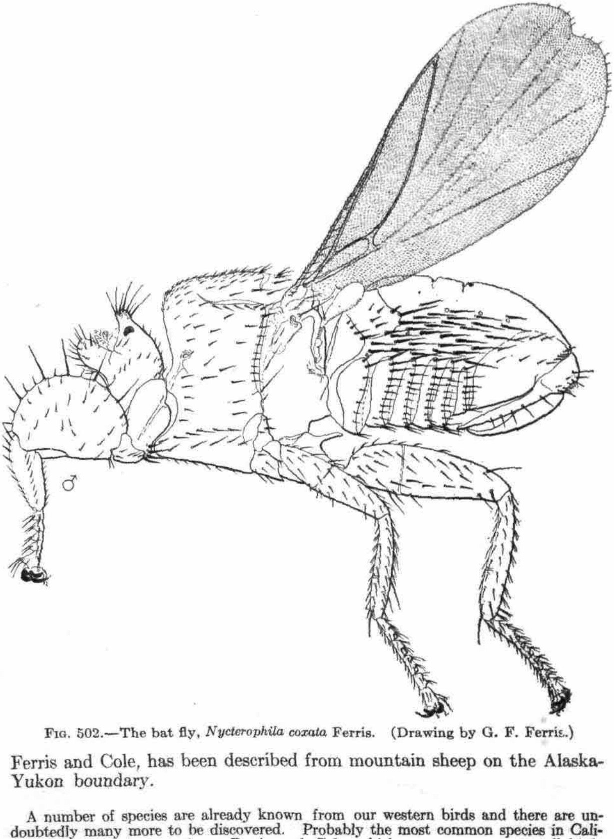

FIG. 502.—The bat fly, *Nycterophila coxata* Ferris. (Drawing by G. F. Ferris.)

Ferris and Cole, has been described from mountain sheep on the Alaska-Yukon boundary.

A number of species are already known from our western birds and there are undoubtedly many more to be discovered. Probably the most common species in California is *Ornithoica promiscua* Ferris and Cole, which occurs on many small birds

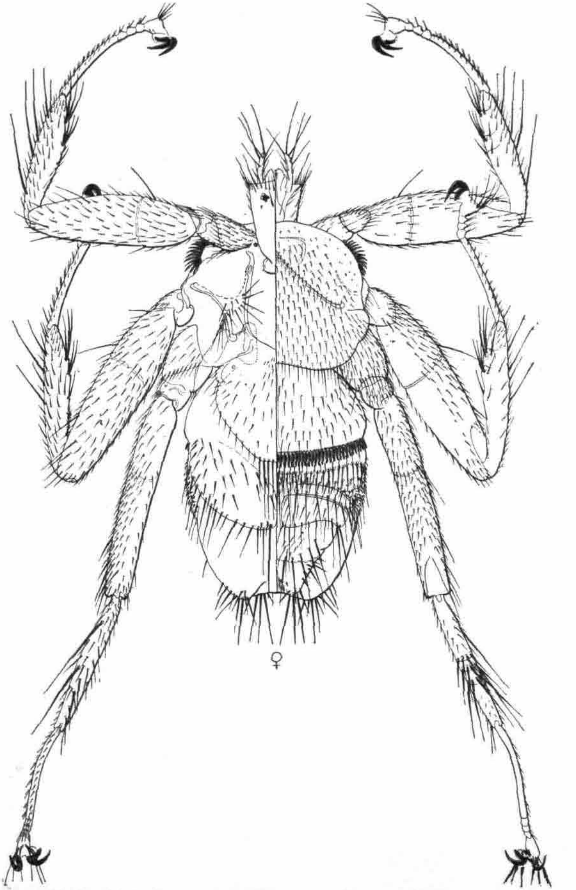

FIG. 503.—The bat tick fly, *Basilia antrozoi* (Townsend). Dorsal and ventral aspects. (Drawing by G. F. Ferris.)

such as the towhees, jays, junco, and others. This is probably our smallest species being but 2.5 mm. long. It is in life of a slightly greenish color. *Ornithoica confluenta* (Say) (Fig. 501) is a common species throughout the country on many passerine birds. *Stilbometopa impressa* (Bigot) is a rather large species known only from the valley quail in California. *Ornithoponus* (=*Olfersia*) *americanus* (Leach) is a moderately large species with the body about 9 mm. long and of a reddish brown color, which occurs commonly on many owls. Certain species of *Ornithomyia* occur on various birds.

The pigeon louse fly, *Lynchia brunnea* Olivier, is dull brown, winged, and 8 mm. in length to the tips of the folded wings. It has been reported from many parts of North and South America, but was first taken in the west by R. R. McLean at San Diego, California, in June, 1925, where he found it killing squabs in a commercial loft. This insect transmits a disease known as pigeon malaria, which is caused by a protozoan, *Hæmoproteus columbæ* Celli and San Felice. J. M. Aldrich who determined the specimens believes it to be identical with *L. maura* Bigot, which causes the same disease to pigeons in Europe, Asia, Africa, and other parts of the world.

STREBLIDÆ. Bat Flies.

This is a very small family of usually very small species which are found only on bats. Two species are known to occur in California. One, *Nycterophilia coxata* Ferris [1] (Fig. 502), a species about 1.5 mm. long that is strongly compressed like a flea, has been described from the California leaf-nosed bat, *Macrotus californicus* Baird. Another, a little flattened species about 1.5 mm. long of the genus *Trichobius*, has also been taken from the same bat.

NYCTERIBIIDÆ.[2] Bat Tick Flies.

These are very remarkable forms, having the thorax greatly flattened and expanded, the legs apparently rising from the dorsal surface, and the head apparently rising from behind the front coxæ. The legs are very long and slender and the insects look almost like spiders. Only eight species are known from North and South America together, although there are more than fifty from other parts of the world. Three species are known to occur in California. They are all from 2–3 mm. long and of a yellowish color. One, *Basilia antrozoi* (Townsend) (Fig. 503), seems to occur quite commonly on the Pacific pallid bat, *Antrozous pacificus;* another, *Basilia corynorhini* (Ferris), is known only from the pale lump-nosed bat, *Corynorhinus rafinesquii pallescens* Miller; and the third, *Basilia forcipata* Ferris, has been taken from *Myotis californicus quercinus* Grinnell in California and from other species of bats of the genera *Myotis* and *Nyctinomus* in other parts of the United States and Mexico.

[1] G. F. Ferris, *Ent. News*, 27, p. 437, 1916.
[2] C. H. T. Townsend, *Jour. N. Y. Ent. Soc.*, 1, p. 79, 1893.
G. F. Ferris, *Ent. News*, 27, p. 434, 1916.

CHAPTER XXVI

SIPHONAPTERA (APHANIPTERA, SUCTORIA) [1] (Order)

(*Siphon*, a tube; *apterous*, wingless)

Fleas

The members of this family are minute insects with complex metamorphosis. The adults vary from 0.8–5 mm. in length; are compressed laterally; the head small; eyes simple or wanting; the antennæ short, stout, three-jointed, and fitting into a groove; the maxillary palpi four-jointed; mouth parts piercing and sucking; thorax with three distinct segments; legs long and powerful and usually for jumping; wings absent or represented by rudimentary scales; abdomen ten-segmented, the last joint internal; body strongly chitinized and tough, clothed with backward pointing hairs and spines and often with a row of short stout spines or ctenida on the edge of the genæ below the mouth called the genal comb, and another on the pronotum known as the pronotal comb, either or both of which may be present or absent. The fleas are ectoparasites feeding on the blood of mammals and birds, and while some are selective, most are not limited to specific hosts. Besides the annoyance and irritation to the host, they can be carriers of disease, such as the Bubonic plague which may be transmitted from rats and ground squirrels to human beings. The small, oval, smooth white eggs are laid on the body or in the nests and habitats of the host. They hatch into small white legless worm-like larvæ (Fig. 506), which have a distinct head, biting and chewing mouth parts, and thirteen body segments which are somewhat hairy. They live in the dust and litter on the ground or in the cracks of floors and feed on organic matter, including feces of adult fleas, and do not live on the hosts. When full grown they pupate in a thin flat silken cocoon which is usually hidden in the debris. Development in warm, moist climates is rapid and continuous, while it is greatly retarded or made impossible in hot, dry, or cold places. A complete life cycle requires from 7–10 weeks in the west. Adults usually live from 8–35 days.

[1] C. F. Baker, "Rev. of Am. *Siphonaptera.*" *Proc. U. S. Nat. Mus.*, 27, p. 365, 1904. "Two New *Siphonaptera.*" *Invertebrata Pacifica*, 1, p. 39, 1904. "Classification of N. A. *Siphonaptera.*" *Proc. U. S. Nat. Mus.*, 29, p. 121, 1906.

K. Jordan and N. C. Rothschild, "Rev. of the Non-combed Eyed *Siphonaptera.*" *Parasitology*, 1, p. 1, 1908. "Contrib. to Knowledge of Am. *Siphonaptera. Ectoparasites*, London, 1, p. 45, 1915.

N. C. Rothschild, "Synopsis of British *Siphonaptera.*" *Entom. Mthly. Mag.*, 51, p. 49, 1915.

A. C. Oudemans, "Morphologie, Ontogenie, Phgylogenie, Systematik, etc. der Flöhe." *Novitates Zoölogicæ*, 16, pp. 133–158, 1909.

M. B. Mitzmain, "Syn. and Biblio. of California *Siphonaptera.*" *Ent. News*, 19, p. 380, 1908. "Some New Facts on Bionomics of California Rodent Fleas." *Ann. Ent. Soc. Am.*, 3, p. 61, 1910.

F. C. Bishopp, *Fleas.* Bul. 248, U. S. Dept. Agr. 1915. "Fleas and their Control." *Farmers' Bul.* 897, U. S. Dept. Agr. 1917.

Preventive and control measures are summarized as follows:

1. Eliminate rats and domestic animals to prevent breeding and dissemination of fleas.
2. Treat domesticated animals with dry buhach, naphthalene, pyrethrum, or wash in solutions of miscible oil or creosote dips.

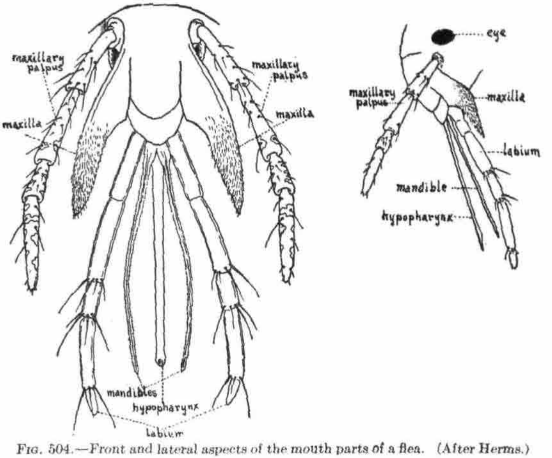

FIG. 504.—*Front and lateral aspects of the mouth parts of a flea.* (After Herms.)

3. Disinfect infested places with calcium cyanide dust, naphthalene, kerosene, creosote dips, or by fumigation.
4. Use only waxed, varnished, or painted floors, with movable rugs or carpets and go over with oil mop if fleas are present.

So much has been written concerning these insects that the writer proposes simply to include a list of the more important western species together with their hosts and distribution.

KEY TO SUBORDERS [1]

Head not jointed, the anterior portion or frons not overlapping the posterior portion or occiput dorsally. . . . . **Integricipita** p. 626

Head jointed, the outer portion overlapping the posterior dorsally. All with genal and prothoracic combs, in the bat fleas the former replaced by two flaps. . . . . **Fracticipita** p. 626

[1] The classification is adapted from N. C. Rothschild, A. C. Oudemans, C. F. Baker, and J. H. Comstock.

FRACTICIPITA (Suborder)

Broken-headed Fleas

KEY TO FAMILIES (Figs. 504, 505)

Ctenidia or comb of the head consisting only of two broad teeth on each side in front of the maxillary palpi, none between the palpi and the antennal groove; apex of the maxillæ truncate .... (**Ceratopsyllidæ**) **Ischnopsyllidæ**

Ctenidia or comb of the head, when present, situated between the maxillary palpi and the antennal grooves or extending from the antennal groove to the anterior margin of the head; apex of the maxillæ pointed .... **Leptopsyllidæ**

LEPTOPSYLLIDÆ (*Ctenopsyllidæ*, *Trichopsyllidæ*, *Hysterichopsyllidæ*).
The European mouse flea, *Neopsylla musculi* (Dugés) (*Leptopsylla*, *Ctenopsyllus*), is a European species which infests mice, rats, and man.

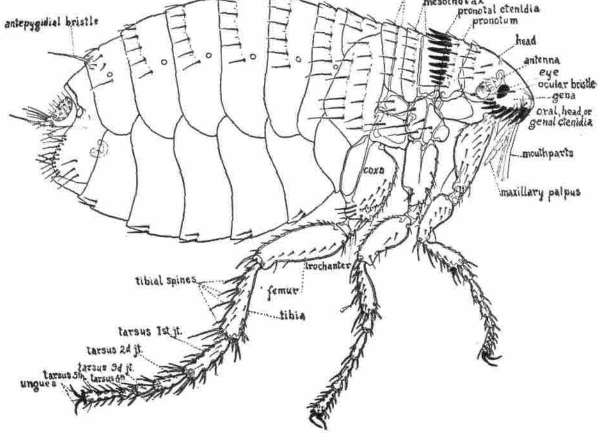

FIG. 505.—The dog flea, *Ctenocephalus canis* (Curtis), showing important anatomical parts. (After Herms.)

It has been taken in San Francisco, California. Eyes are absent in this species.

INTEGRICIPITA (Suborder)

The Unbroken-headed Fleas

KEY TO FAMILIES (Figs. 504, 505)

1. Abdomen with small sharply pointed spines on apices of tergites; inner surface of anterior portion of hind coxæ without small spines; but a patch of bristles is sometimes present .... **Ceratophillidæ** p. 628

Abdomen without apical spines on the tergites; inner surface of anterior portion of hind coxæ with one row of small spines, rarely with more than one row...... 2

2\. Thorax longer than the head, not shorter than the first abdominal tergite........ **Pulicidæ**

Thorax shorter than the head, also shorter than the first abdominal tergite...... **Echidnophagidæ**

ECHIDNOPHAGIDÆ (*Hectopsyllidæ, Sarcopsyllidæ, Rhynchoprionidæ, Dermatophilidæ*).

The chigoe, jigger, or burrowing flea, *Tunga penetrans* (Linn.) (*Pulex, Sarcopsylla, Dermatophilus*), is a small species which is often a serious pest. The females burrow into the flesh and usually infest the feet of cats, dogs, cattle, sheep, horses, birds, and man. The toes of humans are usually infested. The patch of small spines on the inner side of the hind coxæ

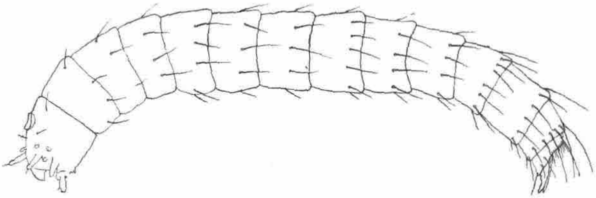

FIG. 506.—The larva of a flea.

is absent. It is a tropical species sometimes introduced into our region but is nowhere established.

The sticktight flea, *Echidnophaga gallinacea* (Westwood) (*Sarcopsylla, Argopsylla*), is a small brown species which is attached in colonies about the eyes, comb, and wattles of chickens. It also occurs in masses about the ears of dogs and cats, and also on rats. This species is known in the south and southwestern parts of the United States and is tropical in origin. It has been recorded in California by Mitzmain. There is present a patch of small spines on the inner side of the hind coxæ.

PULICIDÆ. Common Fleas.

The human flea, *Pulex irritans* Linn. (Fig. 507), attacks humans, poultry, dogs, rats, skunks, and so forth, throughout the world. It is distinguished from the cat and dog fleas by the absence of ctenidia on the head and pronotum.

The Indian or tropical rat flea, *Xenopsylla cheopis* (Roths.) (*Pulex*), is a typical rat flea which occasionally attacks other mammals and human beings. It is the most important factor in distributing Bubonic plague. It occurs in seaport towns of the world. Ctenidia are absent on the head and pronotum; the mesosternite is broad with a narrow thickening from the coxæ upward.

The dog flea, *Ctenocephalus canis* (Curtis) (Fig. 505), is a cosmopolitan species infesting dogs, cats, rats, and humans and is a common household

pest. Ctenidia are present on the head and pronotum; the first spine of the genal ctendia is half as long as the second.

The cat flea, *Ctenocephalus felis* (Bouché), is also cosmopolitan on cats, dogs, rats, skunks, and man, and is common in houses. Ctenidia are present on the head and pronotum; the first spine of the genal ctenidia is about half as long as the second.

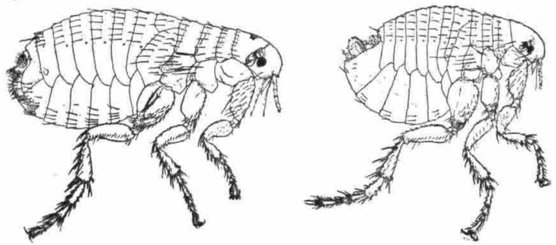

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FIG. 507.—The human flea, *Pulex irritans* Linn. Male and female. (After Herms.)

CERATOPHILLIDÆ (*Dolichopsyllidæ*). Rodent Fleas.

The ground squirrel flea, *Ceratophyllus acutus* Baker, is a predominant species infesting ground squirrels in California and is able to transmit Bubonic plague. *C. abanthis* Roths. attacks meadow mice and skunks in California and ranges north into British Columbia. *C. alaskensis* Baker occurs on ground squirrels at Point Barrow, Alaska. *C. arizonensis* Baker infests the bush rat in Arizona. *C. californicus* Baker occurs on the field mouse in California. *C. ciliatus* Baker attacks the chipmunk in California. *C. dentatus* Baker occurs on lynx in Idaho. **The rat flea,** *C. fasciatus* (Bosc), is a cosmopolitan species on rats, mice, weasels, stoat, skunk, pocket gopher, and man. It is an agent in carrying Bubonic plague. *C. idahoensis* Baker infests ground squirrel in Idaho. *C. ignotus* Baker occurs on pocket gopher, skunks, and ground squirrels in Colorado, California, Idaho, and British Columbia. *C. londoniensis* Roths. infests rats in California. *C. montanus* Baker occurs on the gray squirrel in Colorado and Arizona. *C. multidentatus* Fox infests meadow mouse and wood rat in California. *C. niger* Fox occurs in nests of sparrow, domesticated fowls and pigeons, and on rats and man in California. *C. proximus* Baker occurs on ground squirrel in Southern California. *C. sexdentatus* Baker infests the bush rat in California. *C. terinus* Roths. attacks the ground squirrel in British Columbia. *Hoplopsyllus anomalus* (Baker) (*Pulex*) infests ground squirrels in Colorado and California, and also the Norwegian rat in the latter State. It is able to transmit the Bubonic plague. Members of this genus have the antennal club segmented only on the posterior side.

CHAPTER XXVII

LEPIDOPTERA (Order)[1]

(*Lepis*, scale; *pteron*, wing)

Butterflies and Moths

This is a large order of familiar, small to large insects, with complex or complete metamorphosis. The adults normally have four well developed membranous wings which are entirely or partially covered with overlapping scales or modified hairs, the mosaic arrangement of which is responsible for the varied and beautiful color patterns. They have abortive or suctorial mouth parts, and compound and sometimes simple eyes. The butterflies are diurnal while the moths, with few exceptions, are nocturnal. The larvæ or caterpillars are worm-like with three pairs of true legs and often several pairs of prolegs or sucker feet; biting and chewing mouth parts and simple eyes. The eggs are laid on or near the food. The larvæ are largely vegetable feeders and attack a wide variety of hosts among which are all parts of living plants, including the roots, trunks, limbs, leaves, flowers, fruit, seeds, and so forth, dried cereals, and animal products. A few are predaceous on other insects. Pupation occurs as a naked chrysalis on or in the plant or in a cell in the soil, or in a cocoon composed entirely of silk or of silk and hairs from the body of the caterpillar. Aside from the silk worms and the few predaceous forms, the family is injurious and regularly causes great losses to agriculture, forestry, and commerce throughout the world. There is so much available descriptive literature that only

[1] W. H. Edwards, *The Butterflies of N. A.*, Boston and N. Y. 1, 1868; 2, 1884; 3, 1897.
H. Edwards, "Pacific Coast *Lepidoptera*." 1–22, *Proc. Cal. Acad. Sci.*, 1, 1854; 7, 1876; 2d ser. 1, 1888;4, 1896; also 23–30, San Francisco, Cal., 1877–1880.
S. H. Scudder, *Butterflies of Eastern U. S. and Canada*, 1–3, Cambridge, 1889.
C. P. Gillette, "Cat. Colorado *Lepidoptera*." Bul. 43, *Tech. Ser.* 3, Colo. Agr. Exp. Sta., 1898.
H. G. Dyar, *A List of North American Lepidoptera.* Bul. 52, U. S. Nat. Mus. 1902. (Complete.) "*Lepidoptera* from British Columbia." *Proc. U. S. Nat. Mus.*, 27, p. 779, 1904.
E. M. Anderson, *Cat. British Columbia Lepidoptera.* Prov. Mus., Victoria, B. C., 1904.
W. G. Wright, *Butterflies of the West Coast.* Whitaker & Ray Co., San Francisco, Cal., 1905.
Chr. Aurivillius and H. Wagner, *Lepidoptorum Catalogus*, 1, 1911 to 28, 1923 (continued), W. Junk, Berlin.
W. J. Holland, *The Moth Book.* Doubleday Page and Co., N. Y., 1913. *The Butterfly Book.* Doubleday Page and Co., N. Y., 1914.
Wm. Barnes and J. McDunnough, *Check List of Lepidoptera of Boreal America.* Decatur, Ill., 1917.
Wm. T. M. Forbes, "The *Lepidoptera* of New York and Neighboring States." *Mem.* 68, Cornell Agr. Exp. Sta., pp. 1–729, 1923.
The writer is greatly indebted to Harrison G. Dyar and August Busck for reading and correcting the above manuscript.

the most important and interesting western forms are included in this paper.

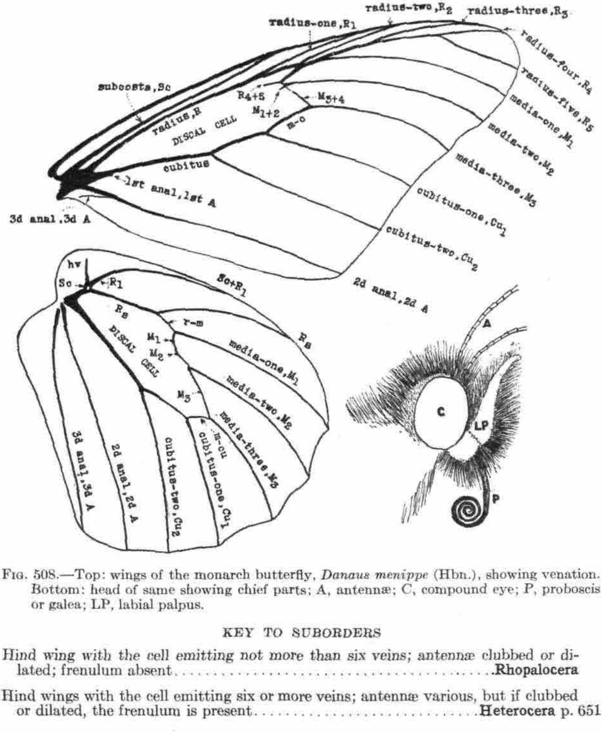


FIG. 508.—Top: wings of the monarch butterfly, *Danaus menippe* (Hbn.), showing venation. Bottom: head of same showing chief parts; A, antennæ; C, compound eye; P, proboscis or galea; LP, labial palpus.

KEY TO SUBORDERS

Hind wing with the cell emitting not more than six veins; antennæ clubbed or dilated; frenulum absent . . . . **Rhopalocera**

Hind wings with the cell emitting six or more veins; antennæ various, but if clubbed or dilated, the frenulum is present . . . . **Heterocera** p. 651

RHOPALOCERA (Suborder)

Butterflies

KEY TO FAMILIES

(Figs. 508, 531)

1. Antennæ wide apart at base, club usually hooked at tip; eyes with prominent fringe of hairs in front; radius of fore wings with five branches all arising from the

discal cell and not forked beyond. Small or medium-sized, usually dull butterflies commonly known as skippers because of their erratic flight. (Hesperids, Skippers.) .... **Hesperiidæ** p. 650
Antennæ approximate at base, club never hooked at tip; eyes without fringe of hairs in front; radius without five branches, stalked or absent 2

2. Front pair of legs strikingly modified from other pairs, at least in the males, usually folded in front and not used for walking, the tarsal claws of same when present never split or toothed 3
Front legs normal or if slightly smaller, the claws are split or toothed 8

3. Front legs greatly reduced in both sexes, tarsi one-jointed in the male and five-jointed in the female and tarsal claws absent on same in both sexes 4
Front legs not greatly reduced, tarsi of females with claws, those of male sometimes with a single claw 6

4. Discal cell of hind wings closed 5
Discal cell of hind wings open, usually medium sized, sober and brightly colored, common butterflies. (Brush-footed Butterflies.) .... **Nymphalidæ** p. 639

5. Front leg of female ending in corrugated knob; subcostal vein in front wing forked at base; antennæ without scales above. Large, often brightly colored butterflies. (Milkweed Butterflies) (*Euplœidæ, Lymnadidæ.*) .... **Danaidæ** p. 639
Front tarsi present and abbreviated; some veins at bases of front wings greatly swollen. Usually of moderate or small size, and dull of color including the Browns and Heaths. They are feeble fliers. (*Agapetidæ.*) .... **Satyridæ**

6. Palpi greatly lengthened, being from one-fourth to one-half as long as the body, thickly hairy and stretched out forward .... **Libytheidæ**
Palpi normal and not greatly lengthened 7

7. Subcosta of hind wing with a spur or humeral vein at the base. (*Erycinidæ, Lemoniidæ, Riodinidæ.*) .... **Rhiodinidæ**
Subcosta without spur or humeral vein at the base; first branch of the media usually arising at or near apex of discal cell. Usually small coppery or blue butterflies. (Blues, Coppers, Hair-Streaks, etc.) (*Ruralidæ.*) .... **Lycænidæ** p. 648

8. All tarsal claws bifid; front tibiæ without pads; hind wings with two well developed anal veins. Small to medium sized mostly white and yellow butterflies marked with black. (Sulfurs and Whites) .... **Pieridæ** p. 635
Tarsal claws large, not bifid or toothed; front tibiæ with pads; hind wing with but one anal vein. Medium to large brightly colored and showy butterflies. (Swallowtails) (*Parnassiidæ.*) .... **Papilionidæ**

PAPILIONIDÆ. Swallowtail Butterflies.

These are large, brightly colored, beautiful butterflies which frequently have the hind wings tailed. The spherical white or colored eggs are laid singly on the larval food plant. The caterpillars are large, usually brightly colored, and frequently have a pair of retractile orange colored scent horns (osmateria) which are enclosed in the segment just behind the head. The naked dull colored chrysalis is attached to various objects by the posterior end and supported by a girdle. Hibernation occurs in this stage. Although common, the members of this family are seldom serious pests.

The daunus, *Papilio daunus* Bdv., is the largest western species, having a wing expanse of 100–140 mm. It is bright yellow with black markings and has two tails on each hind wing. The larvæ feed on very many kinds of rosaceous plants, including Oregon ash, western choke cherry, plums,

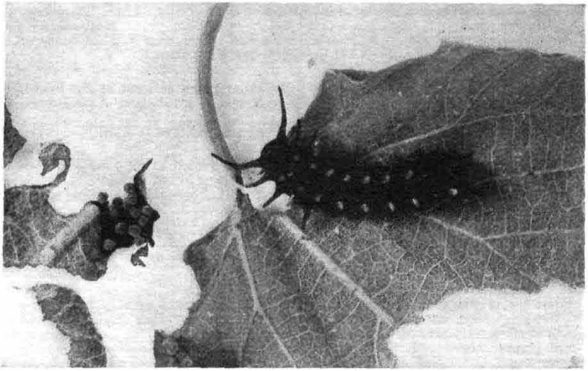


FIG. 509.—Eggs and caterpillar of the pipevine swallowtail, *Papilio philenor* Linn.

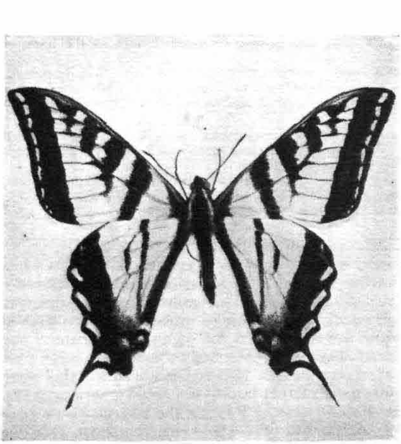


FIG. 510.—The western swallowtail, *Papilio rutulus* Bdv.

and so forth. The species chiefly inhabits the Great Basin region between the Rocky and Sierra Nevada Mountains, extending from Mexico northward into Canada and along the high mountains westward into California, Nevada, Oregon, Washington, and British Columbia.

The eurymedon, *Papilio eurymedon* Bdv., has a wing expanse of 90 to 100 mm., the ground color, pale yellow or whitish with black markings, and the tails usually twisted. The adults visit many kinds of flowers and the caterpillars feed on coffee berry, and on mahala mats and other species

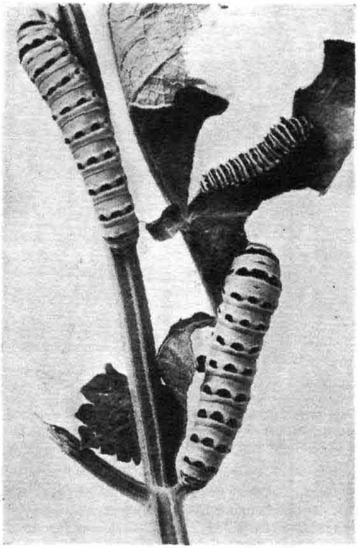


FIG. 511.—Young and mature larvæ of the western parsley caterpillar, *Papilio zelicaon* Lucas.

of *Ceanothus*. It is chiefly a high mountain species occurring in all the Western States.

The pipevine swallowtail, *Papilio philenor* Linn. (*Lærtias*) (Fig. 509), has a wing expanse of 95–105 mm., is beautiful glossy blue-green with pale spots on the dorsum, yellow and orange spots on the venter of the hind wings, and white spots near the under margins of the front wings. The eggs are bright orange and the larvæ are very dark brown with four row of orange spots and numerous soft hornlike projections over the body. The caterpillars feeds on the wild dutchman's pipe or pipevine which grows

abundantly along the Sacramento River and elsewhere in California. It occurs in Arizona and eastward to the Atlantic.

The western swallowtail, *Papilio rutulus* Bdv. (Fig. 510), has a wing expanse of 80–100 mm., and is yellow with black markings. It is the commonest western swallowtail and is the representative in the west of its eastern congener, the common tiger swallowtail, *P. glaucus* Linn. The caterpillars are pale green, the head brown with purplish tints, the body tubercles orange with a buff triangular patch and a green line passing through each. The chrysalids vary from pale green to gray and brown with darker markings. The larvæ feed naturally on alder and willow, but are not uncommonly taken in the orchards on apricot, apple, avocado, cherry,

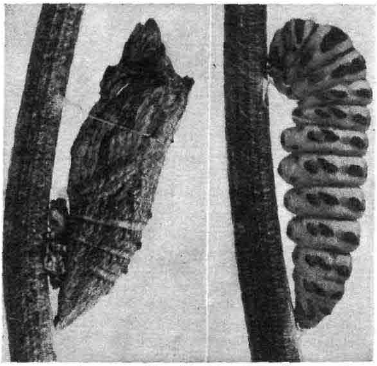


FIG. 512.—The western parsley caterpillar, *Papilio zelicaon* Lucas. Larva transforming to pupa and pupa or chrysalis showing cast off larval skin and points of attachment. Pupa at left.

and prune. *Rubus* spp., wild cherry, wild plum, and sycamore are also hosts. The species ranges throughout the west.

The western parsley caterpillar, *Papilio zelicaon* Lucas (*P. zolicaon* Bdv., *P. californica* Men., *P. coloro* Wright) [1] (Figs. 511–513), has a wing expanse of 80 mm. It is yellow or orange and black, variable, but usually marked as illustrated. The spherical bluish white eggs are about 1 mm. in diameter and laid singly on the host plants. The very young caterpillars are almost wholly black with a yellow blotch near the middle dorsum and many dorsal and lateral orange spots at the bases of the spines. The mature caterpillars are beautiful objects, being bright yellowish green with alternate continuous and broken black bands around the body, orange spots in the broken bands, and an orange scent horn. The chrysalids vary from pale

[1] Also known as the California parsley caterpillar or California orange dog. E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed., p. 454, 1915.
J. R. Horton, *Mthly. Bul.*, Cal. State Dept. Agr. 11, p. 377, 1922.

green to buff, gray, or pale brown. The caterpillars normally feed on members of the parsley family including wild anise, wild carrot, wild parsley, water hemlock, dog fennel, and so forth, and frequently occur in the garden on carrots, celery, parsley, and parsnips. In some sections of California the larvæ also feed on the foliage and young fruit of orange trees, but are

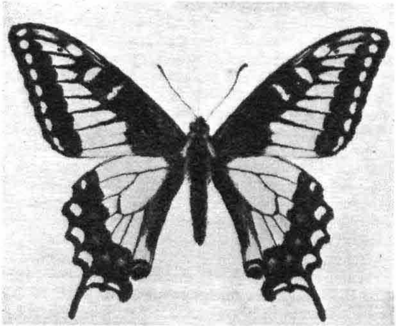


FIG. 513.—Adult of the western parsley caterpillar, *Papilio zelicaon* Lucas.

never sufficiently abundant to be serious. This butterfly occurs throughout the entire western region and is most common in the lower levels.

PIERIDÆ. Sulfurs and Whites.

The pine butterfly, *Neophasia menapia* Felder, has a wing expanse of 45–55 mm., the wings are pure white above, the costal margins and tips of the fore wings marked black, the hind wings with or without a narrow, black sub-apical band, the veins black, and pinkish spots around the margins. The females have much more black than the males. The eggs are flask-shaped, ribbed, scalloped at the narrow top, bright emerald green, and about twice as long as thick. They are laid in single rows on the pine needles during July, August, and September, and do not hatch until the following spring. The caterpillars are 25 mm. long when mature, dark green with a narrow subdorsal and a wide lateral white stripe. They are gregarious and often occur in great numbers. Pupation occurs in June, July, and August. The chrysalis is 15–18 mm. long, green when attached to the needles, and blackish brown when on the bark. The adults appear in July, August, and September, oviposit, and die. This butterfly is often present in countless numbers in the coniferous forests in the higher mountains of California, Nevada, Utah, Colorado, Oregon, Washington, Idaho, and British Columbia, and often completely defoliates great areas of yellow pine and Douglas fir. It also feeds on Jeffrey and other pines. *Neophasia terlooti* Behr is similar to the preceding species, but with heavier black markings in the male, and the female more black than white. Ac-

cording to Dr. H. H. Behr,[1] the larvæ are gregarious in tight sac-like webs and feed on *Arbutus* sp., in the mountains of Arizona and Mexico.

The cabbage butterfly, *Pieris rapæ* (Linn.)[2] (Fig. 514), has a wing expanse of 30–50 mm., is white with the tips of the fore wings black, the female with two, and the male with one black spot, and the hind wings of both sexes with a single black spot on the outer front margin. The under surface of the wings is suffused with yellow. The adults appear early in the spring and continue throughout the entire year in the southern areas, but disappear with the beginning of winter in the north. The tiny, pale yellow ribbed eggs are pointed apically with a rather wide base and are laid singly on the numerous host plants. They hatch in about a week. The caterpillars are of a uniform velvety green and measure about 25 mm. when full grown. Full development requires from one to two weeks and pupation occurs in a pale chrysalis which is attached to the leaves or stems of the hosts or on objects near by, the duration being about the same as that of the larva. The last generation of pupæ hold over as the winter stage. The complete life cycle requires from three to six weeks. Breeding is continuous throughout the summer and fall and there are at least three overlapping broods annually. This insect is a very serious pest to cabbage, but also feeds on brussels sprouts, cauliflower, horseradish, kale, mignonette, mustard, nasturtium, radish, rape, sweet alyssum, turnip, and other wild and cultivated cruciferous plants. It was introduced from Europe into Quebec, Canada, in 1858, and has since spread to all parts of North America, having reached California in about 1883. Artificial control consists in the application of a spray composed of 2 pounds of powdered arsenate of lead, and 2 pounds of fishoil soap (or ½ pound of casein spreader), to 50 gallons of water; or by dusting with 1 pound of powdered arsenate of lead mixed thoroughly with 5 pounds of powdered hydrated lime.

The western white, *Pieris occidentalis* Reak., very much resembles the preceding species, but has the dark markings on the front wings scattered over much of the apical halves and no spots on the dorsum of the hind wings. It is common throughout the west. The larvæ feed on *Cleome* sp., and other wild cruciferous plants. **The southern cabbage butterfly,** *Pieris protodice* Bdv. and Lec., is similar to the preceding one, but the female is often quite dark with almost as much dark as white on the upper surfaces of the wings. The larvæ feed on cruciferous plants. This southern species ranges west into New Mexico, Arizona, Colorado, and California. It is only rarely abundant. It has been gradually replaced throughout the country by the introduced *Pieris rapæ* (Linn.). **The California white,** *Pieris sisymbri* Bdv., is similar to the former with the veins of the fore wings black. The veins on the undersides of the hind wings are widely bordered with gray, interrupted and arranged like arrow points directed towards the margins. The larvæ are green, banded black, and feed on rock cress and other cruciferous plants in Colorado, New Mexico, Arizona, Nevada, and California. **The mustard butterfly,** *Pieris napi* (Linn.), is a small, variable species with the wing veins commonly bordered with brown or dusky scales. It is a European species which now ranges throughout northern North America and as far west as California and Alaska. The larval habits are similar to those of the preceding species.

The western orange tip, *Anthocharis sara* Bdv. (*Euchloe*), has a wing expanse of 30–45 mm. The color is white or yellowish with the fore wings marked by black apical spots and oblique lines separated by a broad bright red or orange band. The dorsum of the hind wings has a marginal row of dusky spots while the under surface is thickly covered with small brownish or dusky markings. The adults begin to appear in April and May and continue in evidence until autumn. The larvæ feed on cruciferous plants.

[1] H. Skinner, *Ent. News*, 11, p. 535, 1900.
[2] F. H. Chittenden, *Farmers' Bul.* 766, U. S. Dept. Agr. 1916.

The species occurs everywhere west of the Rocky Mountains. **The flying pansy or California dog-face,** *Zerene eurydice* Bdv., has a wing expanse of 25–50 mm. and is sulfur yellow with a dark spot near the middle of each fore wing, and two white spots on the underside of each hind wing. The fore wings of the male are iridescent old rose

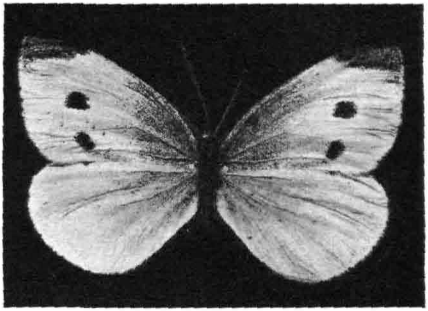


FIG. 514.—The cabbage butterfly, *Pieris rapæ* Linn. Female.

and dark purple, and very beautiful. The larvæ feed on *Amorpha californica* Nutt. The species is common in Arizona, California, and Oregon.

The alfalfa caterpillar, *Eurymus eurytheme* (Bdv.) (*Colias*) [1] (Figs. 515, 516), has a wing expanse of 40–60 mm. and is usually brilliant sulfur or

FIG. 515.—Larvæ of the alfalfa caterpillar, *Eurymus eurytheme* (Bdv.)

orange yellow with the apices of all wings bordered with wide black bands, those of the fore wings often enclosing yellow spots. The fore wings also

[1] V. L. Wildermuth, *The Alfalfa Caterpillar*, Bul. 124, Bur. Ent. U. S. Dept. Agr. 1914. *Farmers Bul.* 1094, U. S. Dept. Agr. 1920.

have a single dark median spot in each and the hind wings have a small and larger pale spot beneath, which appear orange above. Old specimens often appear cream-colored and there is a large range of variations in colors and markings. This is one of the commonest butterflies in the west and is known from the Rocky Mountains to the Pacific. In the alfalfa-growing districts it often swarms over the fields during the summer months. The minute white or brownish eggs are ribbed and cross-lined, and are laid on the host plants. The caterpillars are smooth, bright green with a yellow stripe on each side, and average about 25 mm. when mature. The chrys-

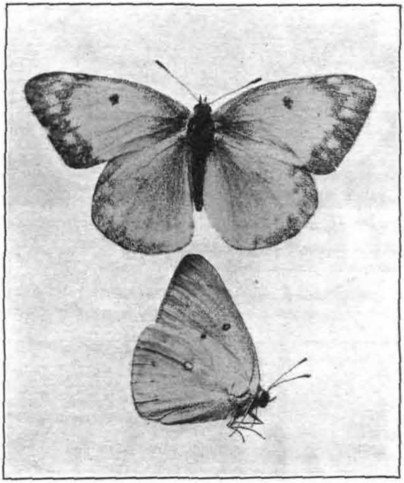


FIG. 516.—Adult butterflies of the alfalfa caterpillar, *Eurymus eurytheme* (Bdv.)

alis is pale green, 20 mm. long, and are suspended on the stalks or nearby objects. Breeding continues rapidly throughout the year in the southern regions, there being six or more broods, while in the more northern limits there are but two broods. Hibernation occurs in all stages in the south and as pupæ in the north. The preferred and most injured host is the alfalfa on which great losses are incurred every year by the attacks of this caterpillar. Clovers, melilotus, lotus, locoweeds, beans, peas, vetch, and other legumes are also infested. Artificial control consists in cutting the alfalfa as soon as the caterpillars appear in the spring to starve the first brood, thus reducing the numbers of the next generation; successive cutting when the alfalfa blooms; frequent irrigations to stimulate rapid growth; disking in the fall to kill hibernating pupæ; pasturing where possible; and the elimi-

nation of volunteer plants outside the fields, which may serve as breeding places. Community action is necessary to secure satisfactory results.

DANAIDÆ (*Lymnadidæ*). Milkweed Butterflies.

The monarch butterfly, *Danaus menippe* (Hübner) [*Anosia plexippus* (Linn.), *A. archippus* (Fabr.)] [1] (Fig. 508), has a wing expanse of 90–100 mm., beautiful orange-brown wings bordered and tipped with black, with black veins and numerous white spots in the black areas of the wings and on the black body. The adults are very common throughout the entire summer and in the southern parts of our regions hibernate in great numbers in thick hedges, appearing on every warm sunny day. They are migratory in habits and their great numbers in many parts of Southern California during the winters are probably the result of a southern migration from the north Pacific States. The eggs are conical-ovate, about 1.2 mm. high, and half as broad, with 22 vertical ribs, and are pale amber-green. They are laid singly on the leaves and stems of the various species of milkweeds, upon which the larvæ feed. The mature caterpillars are about 45 mm. long, yellowish green marked with numerous narrow, entire, and short cross bands of black. The legs are also black. On the dorsum of the second and seventh abdominal segments is a pair of long, black whiplash filaments which twitch excitedly when the insect is disturbed. The larvæ usually occur singly, although many may be found on a single plant. The chrysalis is jade green, suspended by a black stalk, with a black and gold line half around the largest portion, highly ornamented with spots of burnished gold, and is a most beautiful object. The form is robust and the length 27 mm. It is suspended by the tail. The life history requires about thirty days and there are several broods a year. The species is tropical in origin and extends its summer northward migrations throughout the United States and into Canada. In the west it ranges north into British Columbia.

NYMPHALIDÆ. Brush-footed Butterflies.

The gulf fritillary or passion vine butterfly, *Dione vanillæ* (Linn.) (*Agraulis*), has a wing expanse of 60–80 mm. and is of a uniform bright orange-brown above, with black borders, spots, and vein margins, and three small silvery spots enclosed in black near the front middle of each fore wing. The under-surface of the fore wings is orange-red and brown with median and marginal silver spots, while the hind wings are entirely brown with very many large, elongated silvery spots. The eggs are yellow, truncate at the base, rounded at the top, longitudinally ribbed with a few cross lines, and 1.35 mm. high. The mature caterpillars are 37 mm. long and have black head and orange body, the latter with black or gray longitudinal stripes and black spines. The chrysalids are 30 mm. long, green, buff or black, mottled with pale or dark shades. The caterpillars feed often in large colonies on the passion vine and there are two broods annually. The butterfly is tropical and ranges through Mexico northward into the Gulf States, and into New Mexico, Colorado, Arizona, and California in the west. The limits of distribution conform to those of the host plants.

[1] Wm. Barnes and F. H. Benjamin, *Can. Ent.*, 56, p. 16, 1924.

The coronis, *Argynnis coronis* Behr, has a wing expanse of 45 to 70 mm.; the wings are yellowish brown above with distinct dark markings. The undersides of the fore wings are buff with an orange basal area with dark zigzag lines and spots and silver apical spots, while the hind wings are bluff entirely covered with large silver spots and with a characteristic golden submarginal band always present just inside the outer series of silver spots. The larvæ feed on wild and cultivated violets. The species is very common from Southern California into British Columbia and eastward into Utah.

The checker spot or chalcedon, *Euphydryas chalcedona* (Dbldy. and Hew.) [*Lemonias chalcedon* (Dbldy. and Hew.), *Melitæa*] (Figs. 517–519), has a wing expanse of 45 to 65 mm. The upper surfaces of the wings and body are black, the former covered with many small yellow spots. The costal

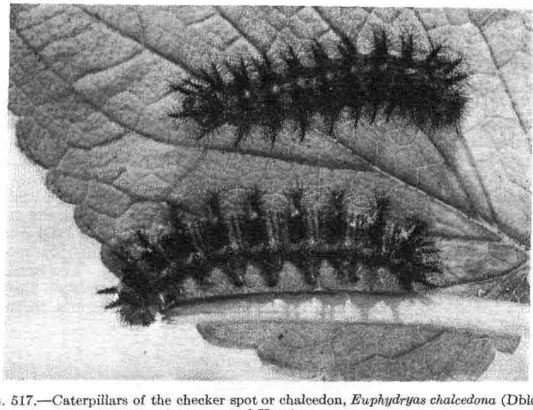


FIG. 517.—Caterpillars of the checker spot or chalcedon, *Euphydryas chalcedona* (Dbldy. and Hew.).

margin is reddish and there are a few small reddish spots interspersed with the yellow, and a row of similar spots near the apical margins of the fore wings. The antennæ and under surface of the body and wings are reddish brown, the fore wings faintly, and the hind wings brightly marked with rows of continuous yellow spots bordered with black lines. The mature caterpillars are 30–40 mm., long, bluish black with small orange markings, and numerous large black compound spines. They feed on aster, buddlea, chrysanthemum, Shasta daisy, figwort, wild gooseberry, hedge nettle, Kenilworth ivy, monkey flower, sticky monkey flower, Indian paint brushes, pentstemons, wild rose, veronica, and many other plants. There are at least two broods; the small, half-grown larvæ of the last fall brood hibernate in small webs. The webbing habit is also common to the young summer caterpillars when feeding. This species is often present in great numbers and is a garden pest in many localities. The chrysalids are pale fawn with

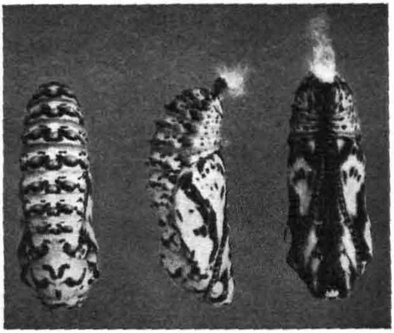


Fig. 518.—Chrysalids of the checker spot or chalcedon, *Euphydryas chalcedona* (Dbldy. and Hew.).

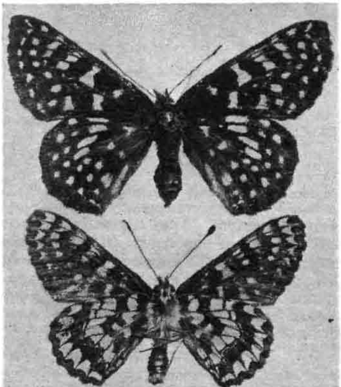


Fig. 519.—The checker spot or chalcedon butterfly, *Euphydryas chalcedona* (Dbldy. and Hew.).

black markings. The butterfly ranges from Mexico north throughout the Rocky Mountain and Pacific States. One part of 40 per cent nicotine sulfate to 600 parts of water affords excellent control and is much more satisfactory than arsenical sprays or dusts.

The satyr or hop butterfly, *Polygonia satyrus* (Edwards) (*Grapta*), has a wing expanse of 45 to 50 mm., the margins of the wings are ragged in appearance, the upper surface is reddish, orange, or amber-brown with distinct dark spots and an apical border on the fore pair. The undersides are marbled various shades of brown with the silver mark in the form of a letter "C" or "G." The caterpillars are blackish, covered with coarse

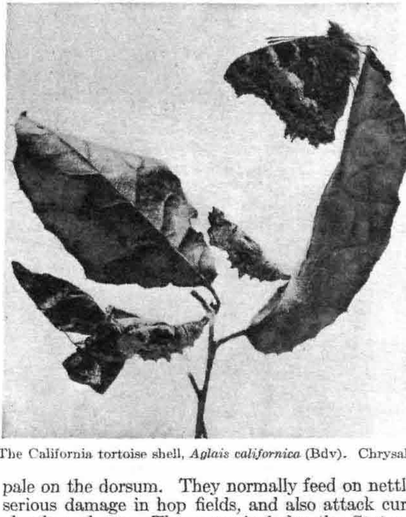


FIG. 520.—The California tortoise shell, *Aglais californica* (Bdv). Chrysalids and adult.

spines, and pale on the dorsum. They normally feed on nettles, but occasionally do serious damage in hop fields, and also attack currant, rhododendron, and other plants. The range includes the States west of the Rocky Mountains and north into British Columbia.

The California tortoise shell, *Aglais californica* (Bdv.) (*Vanessa*) (Fig. 520), has a wing expanse of 50–65 mm., is brown and deep orange above, distinctly marked with black spots and border, the hind wings with a single large basal black spot and a submarginal row of purple spots. The ventral surface is marbled fawn and various shades of brown with narrow irregular submarginal purple line on both pairs of wings. The mature caterpillars are 25–35 mm. long, black, with fine branched spines on each segment, the middle row of spines bright yellow. There are bluish tubercles at the bases of the median row of spines, between which are numerous yellowish dots arranged as a yellow dorsal line. The larvæ feed on various species of the wild lilac, *Ceanothus* spp., and often appear in countless numbers, when alfalfa, manzanita, and other shrubs and

fruit trees may be attacked. The range includes the entire west from the Rocky Mountains to the Pacific Ocean, but the butterfly is most abundant along the coast from California into British Columbia. **The nettle tortoise shell,** *Aglais milberti* (Godt.) (*Vanessa*), has a wing expanse of 45 mm. and has the tips of the fore wings truncate, *all wings dull brown above with a wide submarginal orange band the full width of* both pairs. The caterpillars are black and armed with forked spines. The larvæ are at first gregarious, webbing the tops of the nettles on which they feed. The pupæ are golden, the foreparts tinged with green. This species occurs throughout the entire country and is common in the west.

The mourning cloak or Camberwell beauty, *Aglais antiopa* (Linn.) (*Euvanessa*) (Fig. 521), is one of the commonest and best known butterflies.

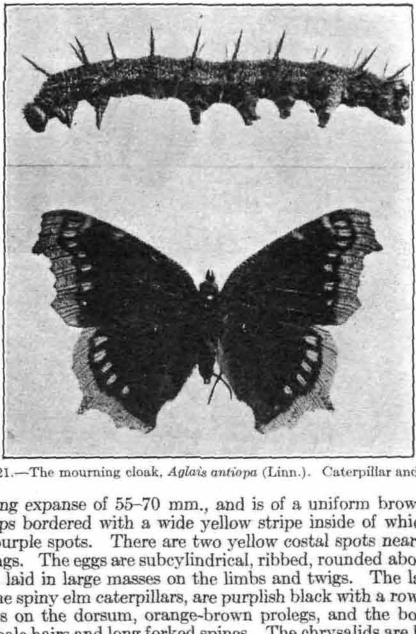


FIG. 521.—The mourning cloak, *Aglais antiopa* (Linn.). Caterpillar and adult.

It has a wing expanse of 55–70 mm., and is of a uniform brownish black, the wing tips bordered with a wide yellow stripe inside of which is a row of blue or purple spots. There are two yellow costal spots near the tips of the fore wings. The eggs are subcylindrical, ribbed, rounded above, orange-brown, and laid in large masses on the limbs and twigs. The larvæ, often known as the spiny elm caterpillars, are purplish black with a row of orange-brown spots on the dorsum, orange-brown prolegs, and the body clothed with short pale hairs and long forked spines. The chrysalids are brown with gray or purple bloom and 22–25 mm. long. The adults appear throughout the year in California, hibernating in the winter and appearing on sunny days. The caterpillars feed on willows, elms, and poplars. The species occurs throughout the entire country.

The red admiral, *Vanessa*[1] *atalanta* (Linn.) (*Pyrameis*) (Fig. 522), has a wing expanse of 50–58 mm.; the upper surface of the wings and body is velvety dark brown or black and characterized by a conspicuous red or orange oblique stripe across the middle of each fore wing and a wide border of the same color along the outer margin of the hind wing. There is a row of white spots along the margins of both pairs of wings, and white and dark spots variously placed on the upper surface. The ventral surface is marbled and

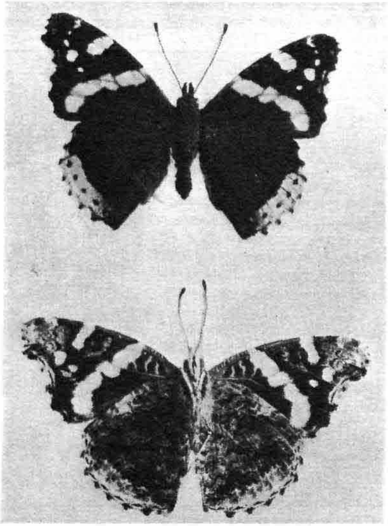


FIG. 522.—The red admiral, *Vanessa atalanta* (Linn.).

marked with many hues of gray, blue, purple, and black, and with a row of five eye spots on each hind wing. The mature caterpillars are 38 mm. long, purplish brown or black, covered with minute whitish specks and a continuous row of yellow spots on each side, and with black or whitish branching spines. They are more or less gregarious and construct nests of web in which they feed. The chrysalids are pale or dark brown with golden dorsal tubercles, and partially covered with a grayish bloom. The species is cosmopolitan and ranges throughout the country. The caterpillars feed on hops, nettles, false nettle, and pellitory.

[1] E. O. Essig, "The Genus *Vanessa* in California." *P. C. Jour. Ent. and Zoöl.*, 8, p. 98, 1916.

The painted lady or thistle butterfly, *Vanessa cardui* (Linn.) (*Pyrameis*) (Fig. 523), is claimed to be the most widely distributed butterfly in the world and is found in all temperate regions and in some tropical areas. It occurs throughout North America and is by far the most abundant species in the west. In Southern California it often appears in great migratory flights, such migrations having been noted in 1895, 1902, 1913, 1914, and 1924. The adults have a wing expanse of 45–65 mm., the upper surface is brown and black, the basal portions of the wings brown, the middle red, and the tips of the fore wings black with white spots, and orange, brown in the hind wings with black and three blue spots. The under sides are marbled gray, buff, and white, the fore wings red near the middle and the hind wings with a row of four distinct and one obscure eye spot in each. The minute, somewhat cylindrical eggs are ribbed and yellow. The full grown caterpillars are 35–40 mm. long, dull brown or black, shiny, with a pale yellow stripe on each side. The chrysalids are iridescent brown or appear as if dipped in molten gold. The adults appear in the spring and continue in evidence until winter. The caterpillars ordinarily feed on thistles, malva, amsinckia, burdock, lupine, nettle, marshmallow, and weeds, but when abundant also attack the globe artichoke, beans, sunflower, and prune. There appear to be at least two broods a year.

The painted beauty or Hunter's butterfly, *Vanessa virginiensis* Drury [*Pyrameis huntera* (Fabr.)] (Fig. 524), is much like the preceding one, but with less red on the dorsum and with but two large eye spots on the under sides of the hind wings. The caterpillars are alternately banded dark purplish, yellowish, and green, with a short row of silvery white spots on each side of the back. They web and feed on thistles, hollyhock, mallow, malva, cudweed, everlasting, blue weed, forget-me-not, senecio, sunflower,

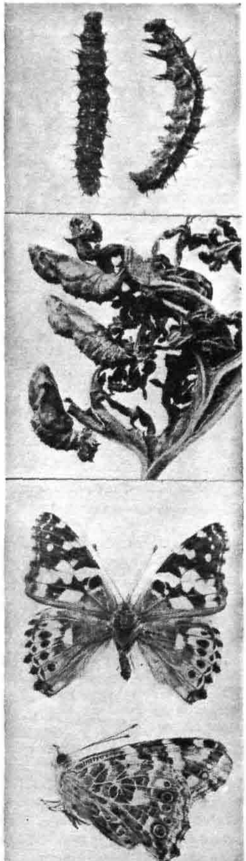


FIG. 523.—The painted lady or thistle butterfly, *Vanessa cardui* (Linn.). Caterpillars, chrysalids, and adults.

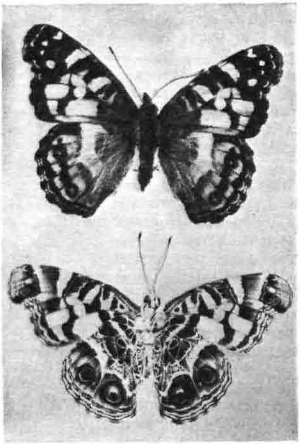


FIG. 524.—The painted beauty or Hunter's butterfly, *Vanessa virginiensis* Drury.

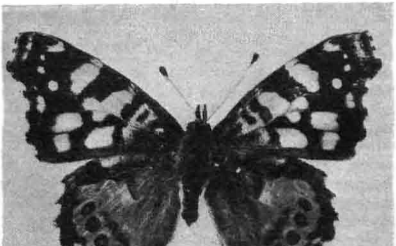


FIG. 525.—The west coast lady or malva butterfly, *Vanessa carye* (Hübner).

and weeds. The species ranges throughout North America and is more or less common in the west.

The west coast lady or malva butterfly, *Vanessa carye* (Hübner) (Fig. 525), is similar to the two preceding species, but has the tips of the fore wings truncate instead of rounded, is usually somewhat smaller, and has a row of five very obscure eye spots on the undersides of the hind wings. The eggs are somewhat cylindrical, rounded above, ribbed, and pale yellowish green. The mature caterpillars are a mixture of black and yellow, either color predominating in different individuals. They feed on and web the leaves of hollyhock, malva, privet, lavender, and mallow. The chrysalids are pale gray to brown with two large and two small silvery spots on the middle of the dorsum. The species ranges from the Rocky Mountains to the Pacific Ocean and north into British Columbia.

The buckeye, *Junonia cœnia* Hbn. (Fig. 526), has a wing expanse of 40–55 mm., the color is a uniform brown above, the fore wings with two short transverse orange spots, an oblique buff line near the middle which embraces a very large eye spot, and a small white area near the tip just in front of a small blue eye spot; the hind wings each have one very large and one small eye spot. The under surface is brown and reddish with the orange spots and the large eye spots of the fore wings showing through. The eggs are shining pale green and spherical with the base flattened. The caterpillars are velvety black with bluish black tubercles and orange on the segments 5–7. They commonly feed on plantain, but have also been taken on foxglove and snapdragon. The chrysalids are black dotted with minute white specks and large white patches. This species ranges throughout the United States and is common in the west.

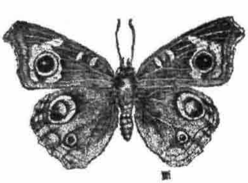


FIG. 526.—The buckeye, *Junonia cœnia* Hbn. (After Woodworth.)

Lorquin's admiral, *Basilarchia lorquini* (Bdv.) (Figs. 527, 528), has a wing expanse of 55–60 mm., the dorsum is black, the fore wings tipped with orange-brown at the base of which color are three small white spots; a row of large white spots extends through the middle of both pairs of wings and a small short white line is isolated near the tip of the cell of the front wing. The under surface is orange-brown with many white markings. The eggs are pale green, spherical with flat base, 0.9 mm. in diameter, and the surface reticulated. The mature caterpillars are 25 mm. long, dull olive or purplish brown, with large patches of white or yellow on the dorsum and sides. A pair of coarse branched spines arises from the second thoracic segment, a large hump occurs on the second abdominal segment, and a smaller hump on the two segments next to the last. They feed singly on willows, poplars, choke cherry, and are commonly taken in orchards of apple and prune trees. The chrysalids are 20 mm. long, gray or brown, mottled with white, and with a large axe-like hump on the middle dorsum. There are two broods, the winter being passed in the second larval stage in hibernaculæ constructed of web and leaves.

The species occurs in California, Nevada, Oregon, Washington, and British Columbia.

The California sister, *Heterochroa bredowi* Hbn. (*Adelpha californica* Butler, *Limenitis*), is a large butterfly with a wing expanse of 75–85 mm. The upper surface is rich velvety brown, the fore wings with two orange and one black band in the cell, a large conspicuous orange spot near the tip, and a wide white oblique band extending nearly to the anal margin of the hind wings. The underside is a most beautiful mixture of metallic pale orange, brown, white, and pearl gray or pale blue. The spherical, ribbed eggs are pale green. The larvæ are pale brown with a pinkish tinge or olive green, the spines black and yellowish, and the body densely clothed with small yellow tubercles. The pupæ are brown with the flattened

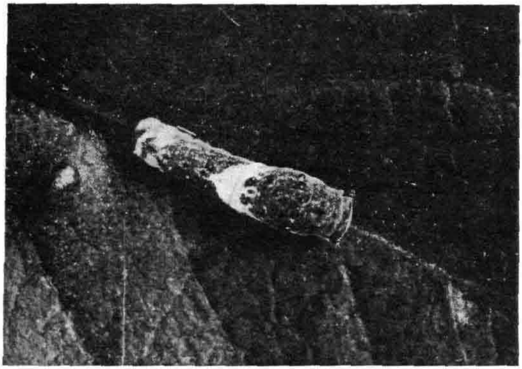


FIG. 527.—Lorquin's admiral, *Basilarchia lorquini* (Bdv.). Young caterpillar on prune leaf. It greatly resembles a bird dropping.

process on the dorsum as in the preceding species. The species occurs in Mexico, Arizona, California, and Nevada, and the caterpillars feed on the leaves of various live oaks.

LYCÆNIDÆ.[1] Lycænids, Blues, Coppers, Hair-Streaks, Gossamer-winged Butterflies.

The great purple hair-streak, *Atlides halesus* (Cramer) (*Thecla*), has a wing expanse of 30–38 mm., is a beautiful iridescent purple, blue or green above, the tips of the wings bordered black and with two large dark spots in the fore pair. Each hind wing has two tails, a very thin one and a wide one which is always twisted. The underside of the thorax is black spotted white, the abdomen orange, and the wings brown, spotted with metallic

[1] W. P. Comstock, "California Species of *Lycænidæ*." *Jour. N. Y. Ent. Soc.*, 22, p. 33, 1914.

green, red, and blue. The larvæ feed on mistletoe. This is a tropical species ranging from Central America through Mexico into the middle of the United States. In the west it extends north into Colorado, Utah, Nevada, and the northern limits of California.

The bean lycænid, *Strymon melinus* (Hbn.) (*Uranotes*) (Fig. 529), is the only common injurious member of the family. The adults have a wing expanse of 25–30 mm. The upper surface is a uniform mouse gray. Each hind wing terminates in a very short and a quite long, slender tail and has a submarginal row of small blue spots, and a large red spot near the margin which partially encloses a black spot. The under surface is pale gray with an indistinct oblique row of orange and blue spots on the front wings and a more distinct row on the hind wings, which also have the two red spots.

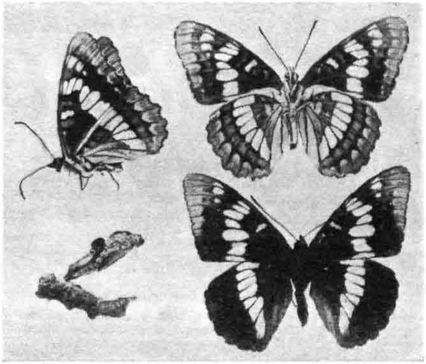


FIG. 528.—Lorquin's admiral, *Basilarchia lorquini* (Bdv.). Chrysalid and adults.

The velvety, pale green, slug-like caterpillars normally feed on native legumes such as locoweeds, tick trefoil, lupines, bush clover, and so forth, and also eat small holes in the green fruit of apples, green developing pods of common and lima beans, and in cotton squares, and the foliage of hawthorn, hog peanut, hound's tongue, hops, peas, pine, and St. John's wort. The species is, however, seldom sufficiently abundant to be a real pest. The distribution includes most of the United States, the species being quite abundant throughout the western region. There are at least two broods.

The arota, *Tharsalea arota* (Bdv.) (*Chrysophanus*), has a wing expanse of 30–33 mm., is wholly dull brown above in the male, and with bright yellow markings on both pairs of wings in the female; the undersides of the fore wings are gray in the male, and yellow, orange, or reddish in the female, with the outer margin lavender; the hind wings purplish gray with black spots and white margins. The adults visit the flowers of *Ceanothus* and the larvæ feed on wild gooseberry and huckleberry. The species

ranges throughout California and is perhaps most abundant in the higher mountains. *T. virginiensis* (Edw.) is almost identical in coloration and is a mountain species occurring in California, Nevada, Oregon, and Colorado.

The knotweed butterfly, *Heodes helloides* (Bdv.) (*Epidemia, Chrysophanus*), is slightly smaller than the preceding one; the upper surface of the male is purplish, the hind wings with a reddish submarginal band, dark outer border, and black spots; in the female the purple is replaced by an orange or reddish color. The underside is paler. The larvæ are common on knotweed, and evening primrose (*Gayophytum*). The species is common throughout the entire west.

The eyed blue, *Glaucopsyche xerces* (Bdv.) (*Lycæna antiacis* Bdv.), has a wing expanse of 33 mm. It is the most common, clear blue butterfly, appearing in the spring in California. The eggs are echinoid in form, pale green with white network. The larvæ are pale green with a median dark green dorsal line and yellow lateral line. They feed on deerweed, lupines, locoweed, and other legumes. *Plebeius acmon* (Dbldy. & Hew.) (*Rusticus, Lycæna*) is a small blue species with an orange border on the hind wings. It is quite common throughout the Rocky Mountain and Pacific States, being known

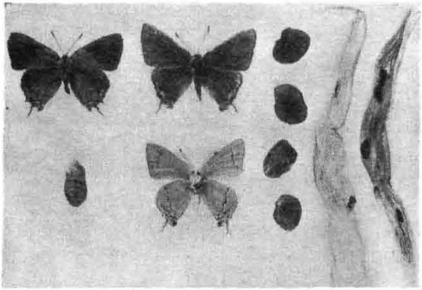


FIG. 529.—The bean lycænid, *Strymon melinus* (Hbn.). Adults, pupa and work of larvæ on beans.

in New Mexico, Colorado, Arizona, California, Washington, and Montana. The larvæ feed on deer weed, wild buckwheat, and locoweed. *Phædrotes piasus* (Bdv.) (*Lycæna*) is one of the earliest appearing small blues which ranges throughout the west from Mexico into Alaska. The adults visit many kinds of flowers and the small pale green slug-like caterpillars feed on lupines and the flowers of the California buckeye.

HESPERIIDÆ.[1] Skippers.

The northern dusky wing, *Cocceius pylades* (Scudd.) (*Thorybes, Eudamus*), has a wing expanse of 35–40 mm., and is of a uniform yellowish brown color above sprinkled with white spots, and paler beneath. The larvæ are dark green with the large head and shield black, and with three dull purplish stripes. When mature they average 28 mm. in length. They feed on clover, bush clover, and tick trefoil. The species ranges from South America north into the United States and Canada. The western range embraces all the States and extends into British Columbia.

[1] H. G. Dyar, "A Rev. of the *Hesperiidæ* of the U. S." *Jour. N. Y. Ent. Soc.*, 13, p. 111, 1905. (Keys.)
Henry Skinner, "Studies in the Genus *Thanaos*." *Trans. Am. Ent. Soc.*, 40, p. 195, 1914.

The gray skipper, *Pyrgus tessellata* Scudd., has a wing expanse of 20–28 mm. and is dark brown covered with many white spots. The eggs are nearly globular, pale green, and laid on the leaf buds of malva, upon which the larvæ feed. This species occurs throughout the United States and is very common in California, Oregon, Washington, and Idaho.

The woodland skipper, *Ochlodes sylvanoides* (Bdv.) (*Anthomaster, Pamphila, Erynnis*), is a small, spotted, dark brown and orange species with a wing expanse of 30–35 mm. The caterpillars feed on grasses. They were taken in destructive numbers on the golf courses of Southern California in 1922. The species occurs in California, Oregon, Washington, Nevada, and eastward into Colorado.

The field skipper, *Atalopedes campestris* (Bdv.) (*Hylephila, Pamphila, Erynnis*), is a small orange and brown species having a wing expanse of 25–35 mm., the orange of the fore wing enclosing a large oval dark spot; the undersides of both pairs of wings are immaculate orange and buff. The larvæ feed on Bermuda and wild grasses. The species occurs throughout the United States and is very common in the central and southern parts of California.

The canna leafroller, *Calpodes ethlius* (Cramer) (Fig. 530),[1] has a wing expanse of 25–30 mm., and is dark brown with several small white spots

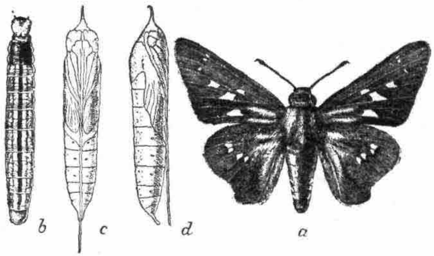


FIG. 530.—The canna leafroller, *Calpodes ethlius* (Cramer). a, adult; b, caterpillar; c and d, chrysalids. (After Chittenden, U. S. Dept. Agr.).

near the middle of the fore and hind wings. The caterpillar is transparent pale green, the head and thorax spotted and tinged with orange. It is naked and attains a length of 40–55 mm. The larvæ feed on and roll the leaves of cannas and are often quite destructive. This butterfly is known in the Southern States and ranges north as far as Washington, D. C. Its presence in the west was first noted near Douglas, Arizona, in 1924 by W. W. Jones, where the larvæ were seriously injurying cannas.

HETEROCERA (Suborder)

Moths

KEY TO FAMILIES[2]

1. Females winged 2
   Females wingless 48

[1] *Circ.* 145, Bur. Ent. U. S. Dept. Agr. 1912.
[2] Modified from Wm. T. M. Forbes, *Psyche*, 21, p. 53, 1914. Some of the newer families are not included.

2. Hind wings with four or five free radials; with at least ten veins besides anals. Wing membrane spinulate. 3
   Hind wings with only one free radial; with at most six veins from cell. 4

3. Wings hardly wider than their fringe, expanse about 12 mm.; tibial spurs present; proboscis short or abortive; mandibles sometimes present; maxillary palpi

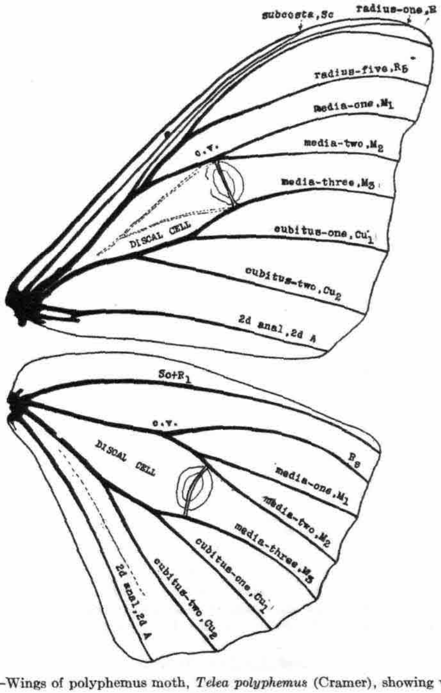


FIG. 531.—Wings of polyphemus moth, *Telea polyphemus* (Cramer), showing venation.

well developed; antennæ long; jugum present. Small metallic moths flying in bright sunlight. Eggs are laid in or on plant tissues. Some larvæ are miners, others feed on mosses. Of no economic importance. (The Little-Winged Jugates) (*Eriocephalidæ.*). . . . . **Micropterygidæ**

Wings normal, fringe narrow, expanse over 25 mm., tibial spurs and maxillary palpi wanting, jugum present; proboscis aborted. A small family of dull colored moths, the larvæ of which feed in the roots of plants. (Swifts.). . . . . . **Hepialidæ** p. 755

4. Wings, especially the hind ones deeply cleft or divided........................ 5
Wings entire or fore wings only moderately cleft........................... 6

5. Each wing divided into six distinct clefts or plumes; proboscis well developed. Small silvery moths. The caterpillars are plants feeders. (*Alucilidæ*.)...... **Orneodidæ**
Fore wings moderately cleft into two, three and four, and hind wings deeply cleft into one, two or three lobes of plumes; proboscis well developed; maxillary palpi absent; small moths of a silvery, gray, buff or brownish color. Larvæ often injurious plant feeders. (Plume Moths.) (see 8)... **Pterophoridæ** (part) p. 712

6. Inner margin of fore wings and costal margin of hind wings narrowly folded and interlocking; fore wings at least four times as long as wide, and at least base of hind and often much of all the wings transparent; proboscis small and rudimentary; body usually slender. Medium-sized brightly colored moths often mimicking wasps. The larvæ are root, stem, and bark borers and often quite destructive. (Clearwings) (*Sesiidæ*.)........................ **Ægeriidæ** p. 720
Wings not interlocking at middle of margin, very rarely transparent, and if so with broader front wings.. 7

7. Hind wings lanceolate, without marked anal angle, or notched below apex and trapezoidal; the fringe almost as wide as the wing or wider.... **Tineina** (in part) 58
Hind wings much wider than their fringe, never lanceolate and rarely trapezoidal; with produced apex.. 8

8. A double series of enlarged and divergent scales along the cubitus of the hind wing below (see 5)............................ **Pterophoridæ** (in part) p. 712
Without such enlarged and divergent scales................................ 9

9. Fore wings with two anals at margin...................................... 10
Fore wings with only one anal reaching the margin; first anal rudimentary or represented by a fold; third anal at most but a short spur................. 15

10. Subcosta and radius of hind wings independent, parallel or arising separately; connected by a cross vein or rarely fused beyond the cell.................. 11
Subcosta of hind wings arising from the cell.............................. 16

11. Subcosta and radius of hind wing connected by a strong cross vein near the middle of the cell or beyond, independent and parallel..................... 12
Subcosta and radius of hind wing not so arranged.......................... 15

12. Fore wing with an accessory or small cell in front of the end of the discal cell.... 13
Fore wing without an accessory cell....................................... 14

13. Wings narrow, bluntly pointed at tips, strong; proboscis absent; body long and thick. Large to medium, nocturnal, dull-colored moths. The larvæ are destructive wood borers. (Carpenter Worms) (see 55)..... **Cossidæ** (part) p. 753
Wings broad, rounded at tips; proboscis absent; body short and slender; palpi well developed. Medium-sized, hairy, yellow or orange colored moths which are nocturnal... **Dalceridæ**

14. Proboscis well developed, palpi and wings scaled. Medium-sized mainly diurnal moths most often with combinations of red, black and green colors. The larvæ are often injurious to plants in the tropics. (*Chalcosiidæ*)............ **Pyromorphidæ** p. 704
Proboscis absent; palpi small and hairy, or absent; wings hairy and dull in color; females wingless enclosed in a case or bag which formerly encased the larvæ. (Bagworms, Case Weavers) (see 48).................... **Psychidæ** (part) p. 703

15. Subcosta arising separately from the radius, running closely parallel to it to well beyond the end of the cell; base of the radius in that case either complete, evident as a short spur or absent; labial and maxillary palpi usually well devel-

oped; proboscis present or absent. Small, nocturnal moths. The larvæ are very destructive to plants, wax, cereal products, dried fruits, etc. (see 18)....... **Pyralidæ** (part) p. 704
Subcosta entirely independent of the radius, or connected by a weak cross vein, or one near base of wing, sharply divergent before the end of the cell........ 50

16. Subcosta arising from near the middle of the cell; sometimes free also for a short distance near the base; proboscis absent. Larvæ slug-like without prolegs. (*Eucleidæ*, *Cochlidiidæ*.)................................... **Limacodidæ**
Subcosta arising near the tip of the cell.................................. 17

17. Hind wings with three anal veins, the first often fading out towards the base.... 18
Hind wings with two anal veins or less, at most with a short spur of the first anal at the margin in the broad-winged forms.............................. 19

18. Subcosta and radius in hind wings closely parallel, or fused beyond the end of the cell; small sober colored moths (see 15).............. **Pyralidæ** (part) p. 704
Subcosta and radius strongly divergent from before the end of the cell........ 50

19. Hind wings rarely reaching beyond the middle of the abdomen; subcosta and radius connected by a strong cross vein at or just before the middle of the cell, then closed parallel to or beyond the end of the cell; antennæ generally thickened anteriorly and often hooked at tip; proboscis well developed and frequently of great length. Large and small moths. Larvæ often of large size and usually with a horn at the posterior end. (Sphinx, Hummingbird and Hawk Moths, Sphinx Caterpillars.)......................... **Sphingidæ** p. 660
Wings proportionately larger, subcosta and radius rarely connected by a strong cross vein, and if so, strongly divergent beyond it; antennæ rarely thickened anteriorly and never hooked.. 20

20. Accessory cell separated by a full-sized vein, or entirely absent............... 21
Accessory cell fused with the discal cell, but with a slight thickening at the line of separation; small species less than 25 mm. in expanse.................... 58

21. Cubitus of fore wings apparently three- or rarely two-branched.............. 22
Cubitus of fore wings apparent, four-branched............................ 35

22. Frenulum normal, well developed.. 23
Frenulum vestigial or absent, less than one-fifteenth the length of the hind wings 30

23. Subcosta and radius of hind wing sharply divergent from near the base. Small delicate moths with large wings........................... **Eucosmidæ** p. 728
Subcosta and radius of hind wings fused or close together for at least part of their course.. 24

24. Subcosta and radius of hind wings separate at extreme base, then close together or fused for a long or short distance..................................... 25
Subcosta and radius of hind wings fused from base to beyond middle, swollen at base then rapidly diverging, very slender. Small dull colored moths with rather narrow fore and wide hind wings. (*Lithosiidæ*) (see 41, 43, 45, 46, 47) **Arctiidæ** (part) p. 673

25. Robust moths, the width of the thorax at least one-sixth the length of the fore wing.. 26
Slender moths.. 29

26. Subcosta moderately thickened and curved at base......................... 27
Subcosta with a strong brace vein from an angle near the base to the base of the frenulum (See 29, 30, 49)......................... **Geometridæ** (part) p. 698

27. Cubitus in hind wings apparently three-branched.......................... 28
Cubitus in hind wings apparently four-branched. Small sober colored nocturnal moths resembling noctuids. (*Polyplocidæ*, *Cymatophoridæ*.)...... **Thyatiridæ**

28. Proboscis absent; palpi present; antennæ pectinate in both sexes; wings usually with clear spots before the tips. Large dull colored moths. The larvæ are very hairy. Mostly tropical.......... **Eupterotidæ**
Proboscis distinct and well developed; wings fully scaled. Moderate-sized to large moths of dull appearance and mainly nocturnal. A large and injurious family. (Prominents.).......... **Notodontidæ** p. 691

29. Spiracles at base of abdomen small and subdorsal; first anal vein usually partly present; subcosta of hind wings slightly bent at base and but slightly enlarged, the humeral angle not expanded; last branch of media and first branch of cubitus stalked in fore wings. Medium-sized pale brown moths. (The Oak Moth.).......... **Dioptidæ** p. 688
Spiracles usually conspicuous, swollen and lateral; first anal absent in all wings; subcosta of hind wings sharply bent or much enlarged at base, almost always with brace vein extending to the base of frenulum. Usually small delicate dull colored moths which are nocturnal. The females are wingless in some species. Caterpillars have a reduced number of prolegs and loop. A large family containing many serious plant pests. (Geometrid Moths, Loopers, Cankerworms, Span Worms) (see 26, 30, 49).......... **Geometridæ** (part) p. 698

30. Subcosta and radius of hind wings either fused for a short distance, then sharply divergent, or separated from the base, or connected by a weak cross vein; spiracles at base of abdomen inconspicuous.......... 31
Subcosta sharply divergent from radius at the extreme base, then sharply bent and touching, fusing with, or closely parallel to it, or connected by a strong cross vein; spiracles on sides at base of abdomen conspicuous (see 26, 29, 49) **Geometridæ** (part) p. 698

31. Antennæ not scaled beyond the basal joint.......... 32
Antennæ closely scaled on upper side.......... 33

32. Two anal veins present; first branch of fore wings fused or stalked with radial stem; frenulum absent. Medium-sized brightly colored moths. Larvæ spiny, pupating in ground without a cocoon.......... (*Citheroniidæ*) **Ceratocampidæ**
One anal vein present or else the upper cross vein at the end of the discal cell, between the last radial and the media, long and longitudinal; proboscis absent; frenulum absent. Usually large, robust brightly colored moths. Larvæ often brightly colored and hairy. Pupation occurs in a silken cocoon. (Wild Silk Moths.).......... **Saturniidæ** p. 667

33. Subcosta of hind wings sharply divergent from the radius from close to the base; fourth and fifth branches of radius stalked, widely separated from the third branch. Medium-sized, robust hairy moths with the wings often notched or concave behind.......... **Lacosomatidæ**
Subcosta and radius of hind wings parallel at base, connected by a weak cross vein.......... 34

34. Frenulum present, about one-sixteenth the length of the hind wing; proboscis aborted. Large dull colored moths. Larvæ hairy and pupating in silken cocoon.......... **Eupterotidæ**
Frenulum absent, or if present not exceeding the front basal angle of the wing; proboscis absent; antennæ bipectinate in both sexes. Medium-sized robust densely hairy or scaly moths. Larvæ smooth with anal horn and pupate in thick silken cocoons. (Silkmoth, Silkworms.).......... **Bombycidæ** p. 697

35. Second cubital vein of fore wings arising from the cell about one-third out or from nearer the base; last radial vein stalked with the first medial; frenulum absent, the basal front angle of the hind wings expanded and furnished with a couple of short extra veins; proboscis absent; antennæ pectinate in both sexes. Medium-sized to large robust mostly brown or sober moths which are nocturnal. The caterpillars are hairy and armed with lateral tufts and pupate in a cocoon of silk and hair. Many species are serious pests. (Tent Caterpillars, etc.).......... **Lasiocampidæ** p. 695

Second cubital vein of fore wings arising well beyond the middle of the cell; frenulum usually present 36

36. Subcosta and radius of hind wings strong and parallel to beyond the end of the cell, then approaching very close or fusing for a short distance; proboscis aborted. Small or medium-sized dull colored, slender nocturnal moths with large wings, the fore pair of which are pointed and curved downward. Caterpillars destitute of hairs and without anal prolegs. Pupation occurs in a silken *cocoon. (Hooktips.)* . . . . ***Drepanidæ***
Subcosta and radius fusing before end of cell; or wholly independent 37

37. Fore wings with the complete twelve veins, all radials, medials and cubitals arising separately or with the second and third radials short-stalked; frenulum *present; antennæ not pectinate; palpi slender and upturned. Small to medium-*sized slender moths of variable colors and hyaline spots on the wings. Mostly tropical and subtropical . . . . **Thyrididæ**
Fore wings with some veins absent, or the third and fourth radials, or the fourth and fifth long-stalked 38

38. Subcosta apparently absent, fused with the radius except at the extreme base; proboscis well developed. Small brightly colored day-flying moths, frequently with hyaline wing spots, and of feeble flight. Many mimic bees and wasps. Larvæ hairy and pupate in cocoon of silk and hair usually on surface of *ground* . . . . **Euchromiidæ** p. 672
Subcosta and radius separating before end of cell 39

39. Antennæ swollen or enlarged toward the tip; frenulum present. Small or medium-sized brightly colored spotted day-flying moths. The larvæ have few long hairs and lateral tufts and pupate in or on the soil without a cocoon. (Wood Moths.) . . . . **Agaristidæ** p. 678
Antennæ regularly tapering toward apex 40

40. Ocelli present, on vertex close to eyes 41
Ocelli absent 46

41. *Fusion of subcosta and radius of hind wing extending to or beyond middle of* cell; antennæ of male pectinate; frenulum present. Small to medium-sized *robust, nocturnal moths of variable and often bright colors. Larvæ hairy and* pupate in cocoon of silk and hairs. A large and injurious family. (Arctiids, Webworms, etc.) (see 24, 43, 45, 46, 47) . . . . **Arctiidæ** (part) p. 673
Fusion of subcosta and radius not exceeding the basal fifth of the cell 42

42. Fusion of subcosta and radius exceeding the basal fifth of the cell 43
Fusion of subcosta and radius less than one-fifth the length of the cell, or imperfect 44

43. Hind tarsus stout, usually not over eight times as long as thick; tibial spurs *often reduced; subcosta greatly swollen at base (see 24, 41, 45, 46, 47)* . . . . . **Arctiidæ** (part) p. 673
Hind tarsus more slender; tibial spurs long; base of subcosta not more than twice as thick as the radius (see 45) . . . . **Noctuidæ** (part) p. 678

44. Swollen spiracles at base of abdomen enlarged dorsally, visible from above as two rounded elevations on the first abdominal segment; medium-sized to large brightly colored or metallic moths . . . . **Pericopidæ**
Swollen spiracles at base of abdomen inconspicuous 45

45. Cubitus of both pairs of wings four-branched, palpi not reaching middle of the smoothly scaled front. Usually white or yellow robust moths (see 24, 41, 43, 46, 47) . . . . **Arctiidæ** (part) p. 673
Cubitus of hind wings three-branched; palpi reaching beyond middle of front; antennæ usually simple; frenulum present. Mostly medium-sized, but also

small and large, robust, scaly dull colored nocturnal, moths some of which have the hind wing brightly colored. The larvæ are smooth, living on plants or in soil and pupating in earthen cell in soil. A very large and injurious family. (Noctuids, Millers, Owlet-moths, Cutworms, Armyworms, etc.) (see 43) . . . . **Noctuidæ** (part) p. 678

46. Fore wings with raised tufts of scales; subcosta free at base, but usually fused with the radius to near the middle of cell. Small moths with narrow fore wings and short rounded hind wings. (*Nolidæ*) (see 24, 41, 43, 45, 46) . . . . **Arctiidæ** (part) p. 673
Fore wings smoothly scaled throughout and without raised tufts of scales 47

47. Subcosta and radius of hind wings fused for a point about the middle of cell, or connected by a cross vein; frenulum present; proboscis aborted or absent. Small to medium-sized dull colored robust nocturnal moths. The antennæ of the males are pectinate. The females often are wingless or with greatly aborted wings. Larvæ hairy with dorsal tufts and pupate in cocoon of silk and hairs. Very serious leaf-eating caterpillars. (Tussock Moths, Gypsy Moth, Brown-tail Moth) (*Liparidæ*) (see 49) . . . . **Lymantriidæ** (part) p. 692
Subcosta and radius fused from the base to the middle of cell. Small dull colored moths. (*Lithosiidæ*) (see 24, 41, 43, 45, 46) . . . . **Arctiidæ** (part) p. 673

48. Adult females legless, never leaving larval case or cocoon (see 14) . . . . **Psychidæ** (part) p. 703
Adult female with legs, and normally developed 49

49. Abdomen closely sealed, spined or with bristly dark gray hair; a few females (see 26, 29, 30) . . . . **Geometridæ** (part) p. 698
Abdomen smoothly clothed with fine, pale wooly hair; adult females not normally leaving the cocoon which is largely composed of larval hair; a few females (see 47) . . . . **Lymantriidæ** (part) p. 692

50. Fore wings with three or four unbranched veins only 51
Fore wings with both branched and unbranched veins 52

51. Large eyecap present (*Opostegidæ*) (see 53) . . . . **Nepticulidæ** (part) p. 755
No eyecap (see 72) . . . . **Heliozelidæ** (part) p. 742

52. Well developed eyecap, fringed with overlapping scales; labial palpi small; discal cell slender or absent 53
Eyecap not developed,—at most with first joint of antennæ large, a little hollowed on inner side, and fringed with a single row of bristles 54

53. Discal cell very small, less than one-tenth the area of the wing, or wholly absent; wing membrane prickly (see 51) . . . . **Nepticulidæ** (part) p. 755
Discal cell larger; wing membrane not prickly. Very small moths. Larvæ leaf-miners and some pupating in ribbed cocoon (see 66, 71) . . **Lyonetiidæ** (part) p. 750

54. Maxillary palpi folded, conspicuous, twice as long as the eye. Small delicate moths. Larvæ living in seed pods and flower stalks of yucca. (Yucca Moths.) **Prodoxidæ** p. 755
Maxillary palpi porrect, shorter than the eye 55

55. Palpi short, at most barely reaching the middle of the front; proboscis absent: thorax and tibiæ densely hairy (see 13) . . . . **Cossidæ** (part) p. 753
Of a different conformation 56

56. Thorax covering consisting of hairs, some of which are broadened at tips; palpi and legs similarly covered; palpi large and usually different in the sexes; wings scaled; venation complete, with base of the media present (see 61, 62, 76, 78) . . . . **Tineidæ** (part) p. 751
Thorax scaled or slender; palpi and front and middle tibiæ also usually scaled; often minute moths with wings tapering towards both ends 57

57. Hind wings with a well marked anal angle, and rounded or somewhat pointed apex, not strongly concave below it; when narrower than fore wings, with three well developed anals.......... 73
Of a different conformation.......... 58

58. Hind wings tapering towards both base and apex, much narrower than the fringe; *fore wings much broader, but also lanceolate*.......... 59
Hind wings of variable size with pointed apex, strongly concave below apex, and again produced more or less on the third medial and first cubital, with well marked anal angle; proboscis well developed; maxillary palpi short. Small delicate moths. The larvæ are naked and feed on plants. A large destructive family (see 81, 84).......... **Gelechiidæ** (part) p. 715

59. *Maxillary palpi present, folded in repose*.......... 60
Maxillary palpi obsolete, or three-jointed and porrect.......... 62

60. Head very rough with bristling vestiture.......... 61
Head smoothly scaled, except narrowly behind. Small moths. Larvæ mainly leaf webbers. Destructive. (*Acrolepiidæ*) (see 76).......... **Plutellidæ** (part) p. 742

61. *Wing membrane prickly*, first branch of the radius of hind wings much stronger than the base of the main stem of the radius, and appearing as a basal fork of the subcosta. Small moths with very long antennæ (see 74)..**Adelidæ** (part)
Wing membrane not prickly; first branch of radius of hind wings no stronger than the basal portion of the radial stem, distant from the base, connecting the subcosta and radius, which are closely parallel toward the base (see 56, 62, 76, 78).......... **Tineidæ** (part) p. 751

62. Head very rough and bristly on both vertex and face; second joint of palpus with lateral bristles toward tip (see 56, 61, 76, 78).......**Tineidæ** (part) p. 751
Lower part of face, at least, smoothly scaled; palpi without bristles.......... 63

63. Fore wings with at most four veins, either free or stalked, to the costa from the cell; with five or six veins running to the inner margin, the fifth branch ex*tending to outer margin (see 82, 88)*.......... ***Yponomeutidæ*** *(part) p.743*
Fore wings with five veins running to the costa from the cell, or with only three or four to the inner margin, the fifth radial extending to the costa.......... 64

64. Vertex roughly bristled.......... 65
Vertex smooth-scaled, or with a few erect scales behind.......... 67

65. Accessory, or cell in front of and beyond the discal cell, very large, extending nearly halfway to the base of the wing; fore wings with heavy spinules on base of the subcosta and base of the cell.......... **Tischeriidæ** p. 747
Accessory cell small, or absent; wing membrane not prickly.......... 66

66. Anal vein of fore wings forked at base; costa of hind wings not lobed (see 53, 71) **Lyonetiidæ** (part) p. 750
Anal vein of fore wing simple; costa of hind wings strongly lobed, with the obscure basal parts of the subcosta and radius closely parallel to the edge of lobe. *Minute delicate moths. Larvæ chiefly leaf miners (see 69, 72)*.......... **Gracilariidæ** (part) p. 748

67. Subcosta and radius of hind wings nearly straight and parallel toward base, usually connected by a distinct, but weak cross vein; rarely, when subcosta is very short, this vein enters the costa beyond the tip of the subcosta; when costa is lobed, with the subcosta fairly straight, and ending at the beginning of the concave portion.......... 68
Subcosta and radius sharply divergent at base; first radial vein, when traceable, appearing as a basal fork of the subcosta, oblique, short and heavy, and the radial stem running nearly through the axis of the wings; or with the subcosta and radius both obscure, closely parallel to the basal lobe of the costa, and the radius functionally replaced by the base of the media.......... 69

68. Palpi upturned to the vertex. Small delicate moths. Larvæ leaf miners and case bearers. (Pistol Case Bearers, Case Bearers.) (see 83) .... **Cosmopterygidæ** (part) p. 714
Palpi minute, drooping .... **Heliodinidæ** p. 741

69. Maxillary palpi present, porrect (see 66, 72) .... **Gracilariidæ** (part) p. 748
Maxillary palpi absent 70

70. Cubital stem in hind wings at least two-branched; palpi usually smoothly upturned to vertex; hind tibiæ loosely hairy .... **Elachistidæ** p. 746
Cubital stem of hind wings simple, free; no cell, or with very short palpi 71

71. Basal joint of antennæ broadened with overlapping scales or a vestige of an eye-cap; proboscis weak; cubitus of hind wings simple; hind tibiæ with a regular series of bristles (see 53, 66) .... **Lyonetiidæ** (part) p. 750
Basal joint of antennæ simple or with a slight comb of bristles 72

72. Palpi usually drooping; if upturned, not reaching the middle of the front (see 51) **Heliozelidæ** (part) p. 742
Palpi moderately long and usually slender, upturned in life (see 66, 69) .... **Gracilariidæ** (part) p. 748

73. Second branch of the cubitus in the fore wings arising less than two-thirds way out of cell. Small delicate moths. Larvæ often injurious plant pests .... **Eucosmidæ** p. 728
Second cubital vein of fore wings arising further out of cell 74

74. Wing membrane prickly; subcosta of hind wings with a strong basal fork or considerably swollen at base; radius and subcosta usually sharply divergent from the base; vertex rough; antennæ often very long (see 61) .... **Incurvariidæ** and **Adelidæ** (part)
Wing membrane not prickly; antennæ never much longer than the fore wings; first radial rarely as strong as the other veins, and when evident separated from the base of the wing by several times its length 75

75. Maxillary palpi four- or five-jointed, folded 76
Maxillary palpi three- jointed or vestigial, projecting 77

76. Head only slightly rough behind (*Acrolepiidæ*) (see 60) .. **Plutellidæ** (part) p. 742
Vertex with long, bristly vestiture (see 56, 61, 62, 78) .... **Tineidæ** (part) p. 751

77. First and second branches of the media both absent in the hind wings .... **Tortricidæ** p. 735
First branch of the media present in the hind wings 78

78. Labial palpi with bristles on each side of the second joint, or the vertex and the front both with extremely long, rough vestiture, and the second joint of the labial palpi heavily tufted and the third joint long (see 56, 61, 62, 76) .... **Tineidæ** (part) p. 751
Labial palpi without bristles; head with short fairly smooth vestiture, or the third joint of the palpi inconspicuous 79

79. Radius and first medial vein of hind wings close together or stalked 80
Radius and first medial vein of hind wings widely separate at base, at least half as far apart as at the margin 85

80. Palpi normally projecting as long as the head, with the second joint triangularly scaled, third less than half as long 81
Palpi upturned to beyond middle of the front, often far beyond vertex, third joint more than half as long as the second and upturned 82

81. Fourth and fifth radial veins separate .... **Phaloniidæ**
Fourth and fifth radial veins stalked to costa (see 58, 84) .. **Gelechiidæ** (part) p. 715

82. *Veins of fore wings all present; fifth radial vein running to outer margin; wings very frequently ornamented with series of dots contrasting with the ground color.* Small moths (see 63, 88) . . . . **Yponomeutidæ** (part) p. 743
   Fifth branch of radius of fore wings extending to the costa or lost 83

83. *Hind wings lanceolate (tapering toward base and apex) narrower than the fore wings* (see 68) . . . . **Cosmopterygidæ** (part) p. 714
   Hind wings not lanceolate, wider than fore wings 84

84. Fore wings with all veins from cell arising separately; radius and first medial vein *in hind wing long stalked.* (*Xyloryctidæ*) (see 38) . . . . **Syntomidæ**
   Fore wings with the fourth and fifth radial veins stalked; hind wings trapezoidal and usually wider, strongly rounded out at the end of the third medial and first cubital (see 58, 81) . . . . **Gelechiidæ** (part) p. 715

85. *Second radial vein arising at the apex of the cell; third medial and cubitals also* closely crowded from lower angle; five radials extending to costa; male usually with strong sexual modifications . . . . **Blastobasidæ** p. 720
   Second radial arising distinctly before the apex of the cell, well away from the origin of the third radial 86

86. Five veins extending from the cell to the costa in the fore wings 87
   Four veins extending from the cell to costa in the fore wings, the fifth radial ending decidedly below the wing tip 88

87. Second branch of media of hind wings arising decidedly nearer to the first than the third medial . . . . **Ethmiidæ**
   Second medial vein of hind wings arising nearer the third medial, or rarely midway between the first and third (see 88) . . . . **Œcophoridæ** (part) p. 719

88. Fourth and fifth *radial veins of fore wings stalked; ocelli absent or vestigial* (see 87) . . . . **Œcophoridæ** (part) p. 719
   All veins in fore wings arising separately, if the fourth and fifth radials are rarely stalked, the ocelli are large (see 63, 82) . . . . **Yponomeutidæ** (part) p. 743

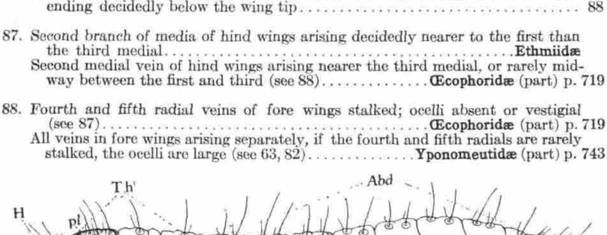


FIG. 532.—A cutworm showing the principal parts of the body. Abd, abdomen; H, head; Th, thorax; a, antenna; alp, anal larvapods or posterior abdominal legs; mlp, median larvapods or median abdominal legs; mxp, maxillary palpus; o, ocelli; s, spines; sp. spiracles.

SPHINGIDÆ.[1] Sphinx, Hummingbird, and Hawk Moths.

The tomato sphinx or southern hornworm, *Protoparce sexta* (Johanssen) (*Sphinx, Phlegethontius*) (Figs. 533, 534), has a wing expanse of 100–125 mm. (4 to 5 inches), the general color being mottled gray with a row of six large orange spots on each side of the abdomen. The members of this

[1] J. B. Smith, "Mon. of *Sphingidæ* of Am. North of Mexico." *Trans. Am. Ent. Soc.*, 15, p. 49, 1888.
W. von Rothschild and Karl Jordan, "*Sphingidæ*." *Genera Insectorum. Fac.*, 57, 1907.

species appear in the spring and again in the late summer and lay the small, globular eggs singly on the leaves of the solanaceous food plants. The small immature larvæ are green, variously marked, while the mature caterpillars

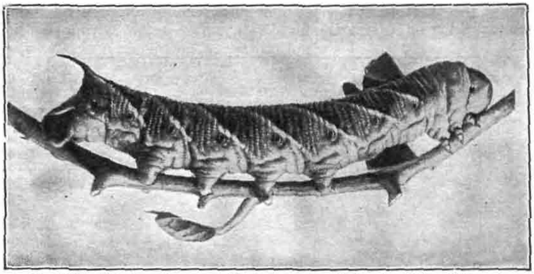


FIG. 533.—The tomato worm, *Protoparce sexta* (Johan.). (After Folsom.)

measure 100 mm., and are pale green with showy oblique white stripes on the sides and brightly colored markings around the spiracles, and are armed with a short curved red horn on the dorsum of the posterior end. They feed on tomato, tobacco, potato, ground cherry, Jimpson weed, and other

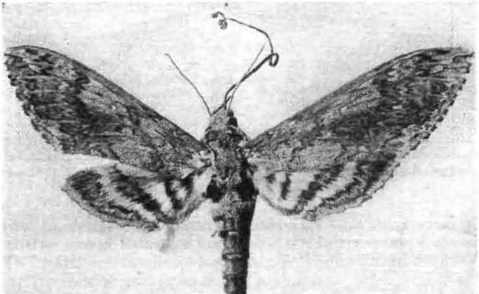


FIG. 534.—The tomato sphinx moth, *Protoparce sexta* (Johan.).

Solanaceæ. When ready for pupation they enter the soil two or four inches and transform into large brown chrysalids about 50 mm. long. These have the proboscis in a sheath like a pitcher handle, which does not extend to

the middle of the developing wings. The fall pupæ remain in the soil during the winter, while those of the summer brood change quickly into moths. There are two generations a year in the southern range and one brood in the north. The distribution includes North and South America and all of the Western States. Under garden conditions control is effected by hand picking or cutting the large caterpillars in two with a pair of scis-

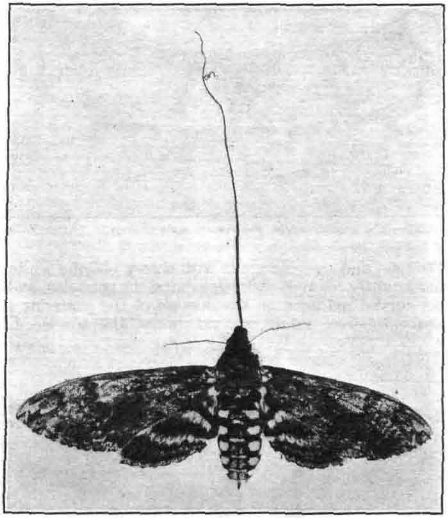


Fig. 535.—The tobacco sphinx moth and adult of the tobacco hornworm, *Protoparce quinquemaculata* (Haw.), with proboscis extended.

sors. In large fields dust with straight powdered arsenate of lead or with a mixture of equal parts of the poison and hydrated lime.

The tobacco hornworm, *Protoparce quinquemaculata* (Haw.) (Fig. 535), is similar in size, color, and habits to the preceding species. The wings of the adults have less of the white markings and there are five orange spots on each side of the abdomen. The lateral oblique white stripes on the larvæ do not extend so far up the back as in the preceding species. The larvæ also have longitudinal white stripes below the spiracles forming "V's" with the oblique stripes, and a black horn. The pupæ have a much longer proboscis which extends beyond the middle of the developing wings. The hosts, distribution, natural enemies, and control are practically the same as for the tomato sphinx.

The Chersis sphinx, *Sphinx chersis* (Hübner) (*Hyloicus*), has a wing expanse of 100 mm., and is dusky with bluish gray scales and black lines on the fore wings and white base, and a bluish line through the otherwise dusky hind wings. The body is gray, the sides of the abdomen alternately banded white and black. The large pale green, bluish-white, or pinkish caterpillars have seven oblique yellow lines on the sides, a large horn, and measure 60 mm. when mature. They feed on native and cultivated cherry, plum, and also on ash, lilac, and privet. There are two broods, the adults appearing in the spring and late summer. The species ranges throughout much of North America and occurs in most of the Western States.

The wild cherry or plum sphinx, *Sphinx drupiferarum* A. & S. (*Hyloicus*), has a wing expanse of 97–106 mm., and is dusky with broad white costal and marginal areas on the fore wings, and white and dusky bands across the hind wings. There is also often a pinkish or yellowish cast to the eastern forms which is absent in the western form, *utahensis* Hy. Edw. The eggs are oval, smooth, and pale yellowish green. The mature caterpillars are 90 mm. long, bright green with seven broad oblique white bands on each side, orange-yellow spiracles, and a large dark brown horn. The pupa is 40 mm. long, reddish brown, with short proboscis case. The larvæ feed on wild and cultivated cherry, plums, and similar trees. The species occurs throughout the country and in all the Western States.

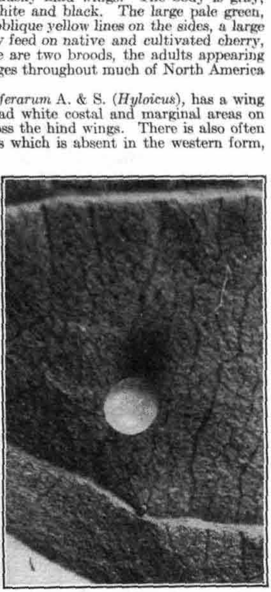


FIG. 536.—Egg of the achemon sphinx, *Pholus achemon* (Drury). (After Nougaret.)

The elegant sphinx, *Sphinx perelegans* Hy. Edw. (*Hyloicus*), is similar to the two preceding species, with dark silvery gray fore wings, crossed by a white submarginal band, and black and white body markings. The moths visit the flowers of the evening primroses and rhododendron and the larvæ feed on manzanita and often injure apple, plum, and prune trees. The range includes the region from California into British Columbia and eastward into Arizona, Nevada, and Colorado.

The sequoia sphinx, *Sphinx sequoia* Bdv., has a wing expanse of 50 mm. and is gray, marked with black and white lines on the fore wings; it has yellowish brown hind wings, and white and black spots on the sides of the abdomen. The moths frequent the flowers of wild cherry and buckeye. The eggs are oval and laid singly on the undersides of the leaves. The mature larvæ attain a length of 50 mm., are pale green, rough, and granular of surface, with green, straight, short anal horn and red spots and oblique lateral lines. According to F. X. Williams[1] they feed on wild cherry and the common and specific names are misnomers, although the type was found resting on a redwood tree. The range includes California and Nevada.

The Vancouver sphinx, *Sphinx vancouverensis* Hy. Edw., is similar in size and coloration to the preceding species, being gray with black lines and white markings on the fore wings, distinct white and black bands on the hind wings, and yellow and black spots on the sides of the abdomen. The caterpillars feed on snowberry. The sphinx occurs throughout the west, being known in Colorado, Montana, Utah, Idaho, California, Oregon, Washington, and British Columbia.

Cerisy's sphinx or the eyed hawk moth, *Smerinthus cerisyi* (Kirby) (*Sphinx*), has a wing expanse of 75–80 mm., and is a very beautiful and common species. The fore wings are marked brown and gray above, the bases of the under surface being rosy, the head and thorax gray, with a large brown central area on the dorsum of the latter, the hind wings gray and brown, overlaid with rose and with a large conspicuous black

[1] *Ent. News*, 16, p. 153, 1905.

and blue eye spot near the anal angle of each, and the abdomen brown above and gray beneath. The eggs are oval and brownish and the first hatched caterpillars are green with a conspicuous horn. The mature forms are green with yellow horn and an oblique line of the same color which extends from the horn forward to the fourth pair of prolegs. The species ranges throughout the country and occurs in all of the Western States. The larvæ feed on willows. **The twin-spot sphinx,** *Smerinthus jamaicensis* Drury, is

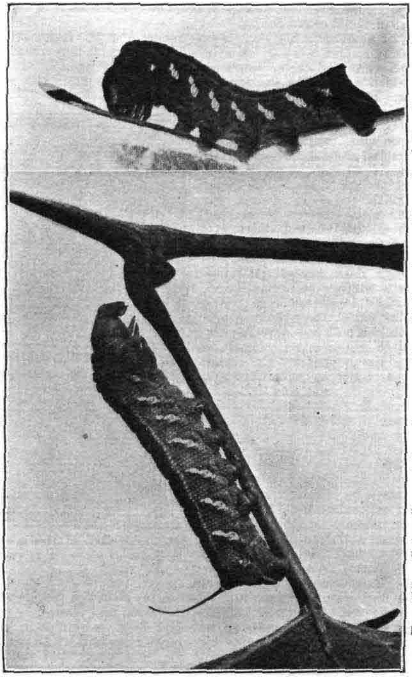


Fig. 537.—Caterpillars of the achemon sphinx, *Pholus achemon* (Drury). (After Nougaret.)

similar to the preceding one, but with two small eye spots in the hind wings. The larvæ feed on apple, ash, elm, wild and cultivated cherries, plums, and willow, and occur throughout the east. In the west they are reported in British Columbia by E. H. Blackmore.[1] The original type was wrongly recorded from Jamaica, hence the misleading specific name.

The poplar hawk moth or big poplar sphinx, *Pachysphinx modesta* (Harris), is a most magnificent moth attaining a wing expanse of 100–150 mm. The color is fawn or pale

[1] Proc. B. C. Ent. Soc., p. 27, 1921.

brown; the upper surface of the fore wings has different bands of these shades and the under surface is purplish red at the base; the hind wings are largely purplish red above and entirely fawn beneath. The mature caterpillars measure 75–100 mm., are green, coarsely granulated with fine white specks, and with pale oblique lateral stripes, and an anal horn. The larvæ prefer cottonwood and poplars, but also feed on willow and, rarely, on apple. The adults visit lights. This species ranges throughout the country and has been recorded in Arizona, Nevada, California, Oregon, and British Columbia in the west.

FIG. 538.—Pupæ of the achemon sphinx, *Pholus achemon* (Drury).

The achemon sphinx,[1] *Pholus achemon* (Drury) (Figs. 537–539), has a wing expanse of 75–100 mm., is marbled brownish gray with well defined dark brown spots on the fore wings and thorax as shown in the illustration. The hind wings are a rich rosy pink with brown border and dark spots. The adults appear in the spring—April and May—and again in July and August, there being two broods a year. They are night fliers and are most active at dusk, darting about rapidly, visiting flowers of evening primroses, rhododendrons, and petunias. They lay the spherical, smooth, pale green eggs, 1.5 mm. in diameter, usually on the upper surfaces of the older leaves near the middle of the vines. The newly hatched larvæ are green with a black horn as long as the body. Growing and mature larvæ may be either green or reddish. The horn disappears with the first molt and maturity is reached in about 25 days. The size then is 60–80 mm. long, there

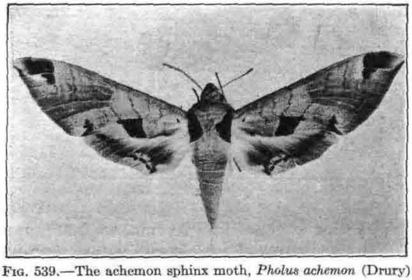


FIG. 539.—The achemon sphinx moth, *Pholus achemon* (Drury).

being a subdorsal lateral yellow line and from six to eight whitish or pale yellow oblique bars on the sides extending across the spiracles. They are ravenous feeders and often defoliate large areas of vineyards in

[1] R. L. Nougaret, "The Achemon Sphinx Moth." *Mthly. Bul.*, Cal. State Dept. Agr. 8, p. 560, 1919.
A. J. Flebut, "Achemon Sphinx Moth in California." *Mthly. Bul.*, Cal. State Dept. Agr. 12, p. 12, 1923.

a comparatively short time. Wild grapes and Virginia creeper are also host plants. Pupation occurs in the soil. The chrysalids are mahogany brown, 45–50 mm. long and those of the second brood remain in the soil during the winter. The moth occurs throughout the country and is recorded in Arizona, Colorado, Montana, and California, and probably occurs in all the other Western States. Serious outbreaks can be effectively checked by spraying with five pounds of powdered arsenate of lead, two pounds of casein spreader and 200 gallons of water when the first young caterpillars appear in the spring.

The white-lined or striped morning sphinx, *Celerio lineata* (Fabr.) (*Deilephila*) (Figs. 540, 541), is the commonest western member of this family.

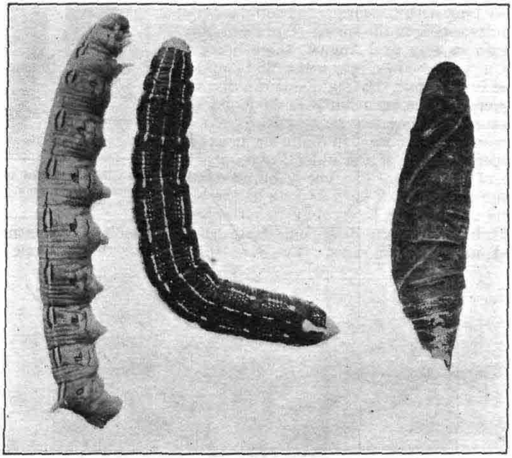


FIG. 540.—Larvæ and pupa of the white-lined sphinx, *Celerio lineata* (Fabr.).

The adults have a wing expanse of 60–90 mm., are dull brown with white lines on the head and thorax, and white and darker brown spots on the abdomen. The fore wings have white lined veins and a broad buff stripe extending from the bases to the tips. The hind wings are dark brown with a wide rosy band across the middle of each. The moths appear at dusk and visit columbines, honeysuckle, moonvine, Jimpson weed, larkspurs, petunia, and many other flowers, and are justly likened to night hummingbirds because of their swift flight from flower to flower. They also collect at lights on warm nights. The larvæ are about 75 mm. long when mature, and are of two colors, bright green and, rarely, black. The common green caterpillars have the head and anal horn yellow, a subdorsal row of

pale spots bordered above and below with a black line, and brightly colored spots around the spiracles. The dark forms are wholly black above with three dorsal yellow lines and broken black lines on the sides and at the bases of the legs. The head, shield, and anal horn are yellow or orange. Pupation occurs in the soil. The shining dark brown chrysalids are 30–35 mm. long. There are two broods. The caterpillars are omnivorous feeders and when abundant consume all forms of plant life. Among the principal hosts are apple, azalea, beets, buckwheat, chickweed, collards, currant, bitter dock, elm, evening primroses, fuchsia, gooseberry, grape, melons, pear, plum, portulaca, prune, purslane, tomato, turnip, and many other range, forage, and truck crop plants. The species occurs throughout the

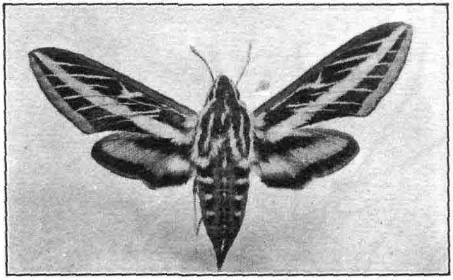


FIG. 541.—The white-lined sphinx moth, *Celerio lineata* (Fabr.).

entire west and the United States. Control measures are the same as for the achemon sphinx.

SATURNIIDÆ. Wild or Giant Silk Moths and Day Flying Moths.

The ceanothus silk moth, *Samia euryalus* (Bdv.) [*S. rubra* (Behr), *S. ceanothi* (Behr), *S. californica* Grote],[1] (Fig. 542), is a common, very large, hairy, reddish moth with a wing expanse of 95–130 mm. The outer margins of the wings are clay colored with a fine winding brown median line and a conspicuous submarginal white line bordered on the inside with black. The fore wings have a whitish and blackish area near the base, a transverse median white spot bordered with black, and pinkish-purple tips. The hind wings have a larger elongated and painted white spot edged with black near the middle of the basal reddish area. The collar and the base and posterior bands of the abdomen are white. The larvæ attain a length of 80 mm., are pale green with pale blue dorsum, short stout golden tubercles on the dorsum, and bluish tubercles on the sides. They feed chiefly on ceanothus and California coffee berry, but are occasionally taken on apple, mountain birch, willow, and manzanita. The cocoons are gray, elongated, pointed at both ends or oval, and 50–60 mm. long. They are attached by

[1] For synonymy see J. McDunnough, *Can. Ent.*, 53, p. 191, 1921. H. G. Dyar does not agree with this change.

the side to small limbs or suspended from one end. There is but one brood. The winter is spent as pupæ in the cocoons and the adults emerge in the spring. The species is strictly western, occurring in California, Oregon, Washington, British Columbia, Nevada, Utah, and Wyoming.

Glover's silk moth, *Samia gloveri* Strecker,[1] has the outer half of the wings clay and the inner half reddish. The mature caterpillars are 80 mm. long, yellowish green with black spots between the two rows of dorsal tubercles, and with black spines. They feed on currant, gooseberry, maple, box elder, elm, and willow. The cocoons are 70 mm. long and pointed at

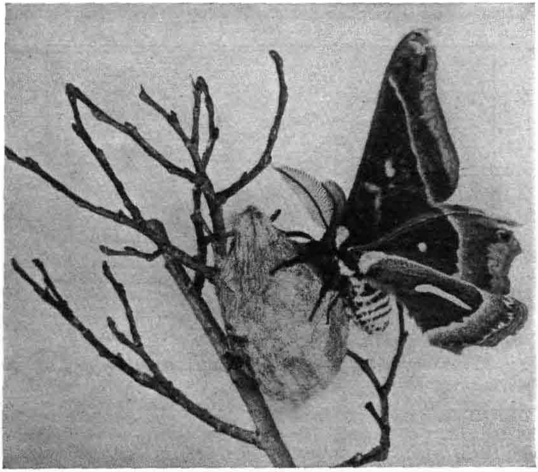


FIG. 542.—The ceanothus silk moth, *Samia euryalus* (Bdv.) [*S. rubra* (Behr)], just emerged from the cocoon. Male.

both ends. The species ranges throughout the Rocky Mountains in New Mexico, Arizona, Colorado, Wyoming, and Montana. **The cecropia moth,** *Samia cecropia* (Linn.), ranges west into parts of Montana. The larvæ feed on many rosaceous plants, including fruit trees, and also on lilac, maples, willows, deciduous forest trees, and so forth.

The polyphemus moth, *Telea polyphemus* (Cramer) (Figs. 531, 543), has a wing expanse of 110–120 mm., and is ocherous brown or reddish. The bases and margins of the wings are clay or buff separated from the darker median portions by parallel bluish and pink lines. There is a yellow marginal eyespot near the middle of each wing, while the eyespots in the hind

[1] R. A. Cooley, *Sixth Ann. Rept.* Ent. Mont. Bul. 75, Mont. Agr. Exp. Sta., p. 109, 1908. Illustrated.

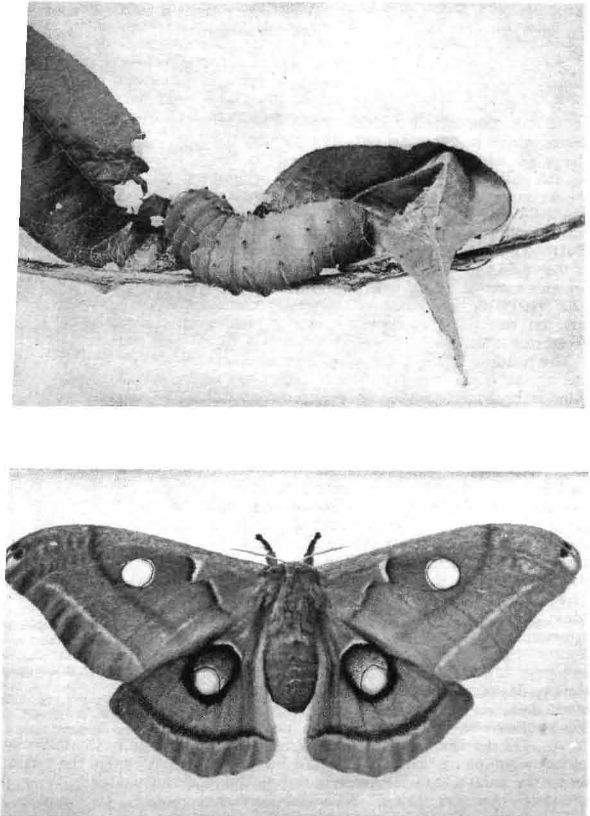


FIG. 543.—The caterpillar of the polyphemus moth, *Telea polyphemus* (Cramer), beginning to construct cocoon on peach twig, slightly reduced, top. Female at bottom.

wings are heavily margined with black and blue. The mature caterpillars are pale green with seven oblique pale yellow lines on each side; the segments each with six short tubercles arising from a livid red spot; and the spiracles pale orange. They feed on alder, apple, basswood, butternut, cherry, elm, hazel, madrona, maple, deciduous and live oaks, peach, pepper, prune, plum, quince, and willow. When ready to pupate they spin a large oval cocoon 35–40 mm. long attached inside of one or several leaves which serve as an outside covering, the stems of which are tightly fastened to the branch with silk to prevent the natural drop in the autumn. The large suspended cocoons are readily discernible in fruit orchards during the winter months and are readily gathered and destroyed by the growers. The adults emerge in the spring and lay the flattened, biscuit-like, brownish eggs on the leaves of the host plants. The species is single-brooded, ranges throughout the country, and occurs in many of the Western States.

FIG. 544.—Newly emerged larvæ of the buck-moth *Hemileuca maia* Drury, leaving the egg cluster in the spring after hibernating as tiny larvæ within the egg shells. (Photo by S. B. Doten.)

The pandora moth, *Coloradia pandora* Blake,[1] has a wing expanse of 80–95 mm. The general color is brownish gray with black lines and a single black spot on each wing and white scales scattered over the fore wings. The hind wings are pinkish with black margins, a black band near the middle, and a single oval black spot in each. The under surfaces are partially clothed with pinkish hairs. The antennæ and parts of the legs are orange and the body is clothed with long black and white hairs intermixed. The eggs are flattened or biscuit-shaped, smooth, shining pale green, and are laid in clusters on the bark of the pine trees in May, June, and July. The young caterpillars appear in August and are black or brownish; the mature forms are green or greenish brown, leathery, and measure 50 mm. They feed on the needles of yellow pine and Jeffrey pine, and often defoliate large areas of standing timber. They hibernate in a nest of pine needles in the tops of the trees as immature forms and develop rapidly the following spring, reaching maturity in June and July. Pupation occurs in the ground under the trees where they remain during the following winter and emerge as adults the next spring. Two years are thus required to complete a full life cycle. This accounts for the adults appearing in cycles of two years.

[1] J. M. Aldrich, *Jour. N. Y. Ent. Soc.*, 20, p. 28, 1912. *Ann. Ent. Soc. Am.*, 14, p. 36, 1921.
W. J. Chamberlin, *Jour. N. Y. Ent. Soc.*, 30, p. 70, 1922.

The caterpillars are used for food by the Pai-Ute Indians, who set fire to the rubbish beneath the infested trees after carefully encircling them with trenches to prevent the spread of the fire. The smoke causes the worms to drop in great numbers. They are gathered and dried and subsequently cooked into a stew called Pe-aggie by the Pai-Ute Indians of the Mono Lake Region, according to J. M. Aldrich. J. E. Peterson[1] reports the Klamath and Modoc Indians roasting the pupæ for food. The distribution includes the yellow and Jeffrey pine belts in the Western States of New Mexico, Colorado, Wyoming, Montana, Utah, Nevada, California, and Oregon.

The Nevada buck-moth, *Hemileuca nevadensis* Stretch (*H. californica* Wright), has a wing expanse of 70–75 mm., and is white or yellowish, the abdomen brown or black with a yellow, orange, or red anal tuft, the wings black or dusky at the bases, and the apical margins with a dark blotch surrounding a white spot in each wing. The moths

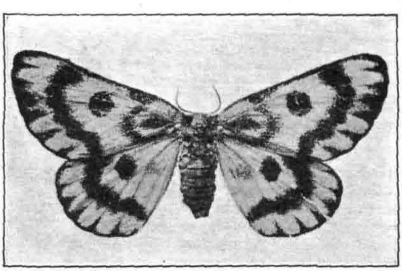


FIG. 545.—The brown day moth, *Pseudohazis eglanterina* (Bdv.). Female.

appear in the fall and fly during the day. The orange colored eggs are laid in the fall in masses encircling small twigs, and the minute fully formed caterpillars remain in the shells until the first warm spring day when they emerge in a remarkably short time. They feed gregariously on willow and poplars. Mature caterpillars are spiny, yellow and black subdorsally and below, and with the upper row of spines long and brown. Pupation occurs in the rubbish at the bases of the hosts. The adults appear in September. The distribution includes New Mexico, Arizona, Colorado, Utah, Nevada, and California. *H. electra* Wright has a wing expanse of 50–55 mm., the fore wings are marked black and whitish or yellowish, and the hind wings reddish orange with black borders and a median black spot in each. The body is orange with dark hairs on the thorax, and black spots on the sides and often on the dorsum of the abdomen. The caterpillars feed on wild buckwheat. The species is day-flying and occurs in Southern California. **The buck moth,** *H. maia* Drury (Fig. 544), is blackish with a wide whitish band extending across both pairs of wings and enclosing or touching the wing spots. The caterpillars feed on willows, oaks, and meadow sweet in New Mexico, Colorado, and eastward. *H. juno* Packard occurs in Mexico, New Mexico, and Arizona. The caterpillars feed on willows, cottonwoods, and poplars. **The New Mexico range caterpillar,** *Hemileuca oliviæ* Cockerell,[2] is a serious range pest in Mexico and New Mexico and extends north into Colorado. The adults have a wing expanse of 55–65 mm., the body is reddish, brown, or black, the wings clay or buff, the fore

[1] *Insect Pest Survey*, Bur. Ent. U. S. Dept. Agr. 3, p. 94, 1923.
[2] C. N. Ainslie, Bul. 85, pt. 5, Bur. Ent. U. S. Dept. Agr., p. 59, 1910.
V. L. Wildermuth, Bul. 443, U. S. Dept. Agr. 1916.

pair crossed with two wide paler stripes and the hind wings immaculate. They are day flying, appear in October and November, and deposit the biscuit-shaped reddish brown eggs in masses around the stems of plants. The minute larvæ hibernate in the eggs and hatch in the spring. Mature larvæ are yellow, gray, or black, densely covered with coarse spines with dark red or black head and white spiracles encircled with a black line. The spines are poisonous. The caterpillars feed on wild grasses and at times also infest corn and cultivated crops.

The brown day moth, *Pseudohazis eglanterina* (Bdv.) (*P. shastensis* Behr) (Fig. 545), has a wing expanse of 65–75 mm., and is various shades of purplish pink, yellow, or orange with conspicuous black markings as illustrated. The moths appear in the fall and are a day-flying species. The salmon or orange colored eggs are laid in large masses around small twigs in the fall of the year, and remain over winter protecting the already formed caterpillars which do not emerge until spring. The mature caterpillars are 50–60 mm. long, dark brown or dull black, with reddish dorsal spots and a narrow red line on each side, and covered with stout, many-branched, black and tan spines. They normally feed on ceanothus, coffee berry, cascara sagrada, manzanita, willows, wild blackberry, wild cherry, wild grape, wild rose, and so forth, but also readily attack prunes, cherry, plums, roses, and grapes. Pupation occurs in the rubbish at the bases of the plants. H. G. Dyar[1] believes that the second winter is spent in the pupal stage, thus requiring two years for a complete life cycle. This point has not been definitely decided. The species occurs in the Rocky Mountain and Pacific Coast States and is common in California, Oregon, Washington, British Columbia, and east into Colorado. The larvæ are often covered with the small white cocoons of the hymenopterous parasite, *Apanteles electræ* Vier. (see Fig. 655).

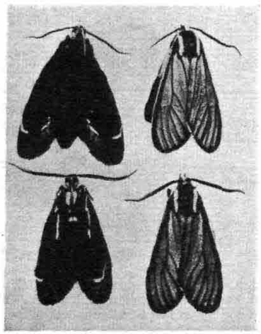


FIG. 546.—The brown ctenucha, *Ctenucha brunnea* Stretch.

EUCHROMIIDÆ (*Syntomidæ*). Syntomid Moths.

Members of the genus *Ctenucha* are brightly colored with velvety black or brown wings, and metallic blue or purplish bodies marked with bright orange or red around the head and shoulders. They are slow day-flying moths which prefer to cling to the host plants, but become quite active when disturbed. They appear in June and July. The eggs are round, somewhat flattened dorsally, pearly white when first laid, but becoming deep yellow or brownish with age. They are laid in rows in small or large groups. The mature caterpillars are 18–25 mm. long and entirely clothed with thick, long, buff or brown hairs, and with two anterior and one posterior black tuft on the back. They feed in coarse native grasses. The pupæ are dark reddish brown, 18 mm. long, and occur in the soil.

The common western forms are separated by the following key:

1. Fore wings with white or reddish veins.................................... 2
   Fore wings with black or concolorous veins.................................... 3

2. Veins of the fore wings reddish..............................*C. venosa* Walker
   Veins of the fore wings whitish..............................*C. cressonana* Grote

[1] Life History. *Psyche*, 7, p. 91, 1894.

3. Area between and around the eyes brown or black............................ 4
   Area between and around the eyes red..................*C. rubroscapus* Mén.

4. Fore wings pale brown......................................*C. brunnea* Stretch
   Fore wings very dark brown or blackish...................*C. multifaria* Walker

Ctenucha venosa Walker occurs in Mexico, Texas, New Mexico, and Colorado. *C. cressonana* Grote is a Rocky Mountain species. *C. rubroscapus* Ménétries ranges in the Sierra Nevada mountains of California and frequents streams. *C. multifaria* Walker is common in the lowlands of the San Francisco Bay region, California. *C. brunnea* Stretch [1] (Fig. 546) infests wild rye in Southern California.

ARCTIIDÆ. The Arctids, Tiger Moths, Footman Moths.

The silver spotted halisidota, *Halisidota argentata* Pack., has a wing expanse of 45–50 mm., and is yellowish, the fore wings reddish brown with numerous uniform silvery white spots, and the hind wings with a few brown markings near the costal margin.

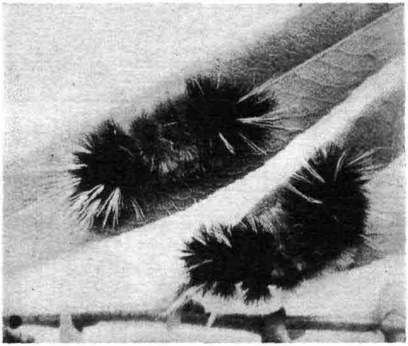
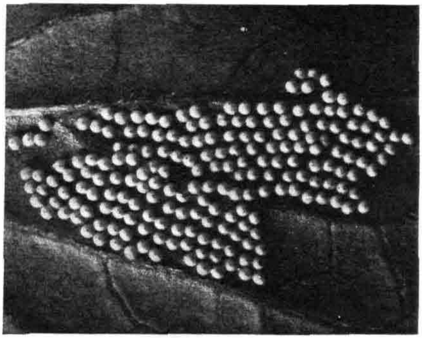


FIG. 547.—Yellow and black caterpillars of the spotted halisidota, *Halisidota maculata* (Harris), on willow leaves.

The hairy black and yellow caterpillars feed on pines, firs, and other conifers, and are often quite destructive in the native groves of Monterey pine in California. The species occurs in Colorado and westward in California and Oregon. The caterpillars of *Halisidota ingens* Hy. Edw. infest young yellow pines in Colorado. **The spotted halisidota,** *Halisidota maculata* (Harris), has a wing expanse of 35–50 mm. and is yellowish buff with the fore wings usually spotted and marbled various shades of brown. The race *angulifera* Walker occurs in the high mountains of the west, while the races *agassizi* Packard and *eureka* Dyar inhabit the Pacific coastal regions. The caterpillars (Fig. 547) are 25–35 mm., long when mature, densely hairy, black with white or yellow hairs intermixed, and a wide yellow median belt with dorsal black tufts. In the form *alni* Hy. Edw. the median dorsal tufts are reddish in the immature forms. They are commonly known as woolly bears and feed on willows, maples, oaks, poison oak, ironweed, hazel, Juneberry, wild plum, elm, judas tree, hickory, beech, black locust, alder, and poplar. Pupation occurs in a gray felty cocoon of silk and body hairs. The species ranges throughout the country and is common in all the Western States.

[1] E. O. Essig, *P. C. Jour. Ent. and Zoöl.*, 7, p. 241, 1915.



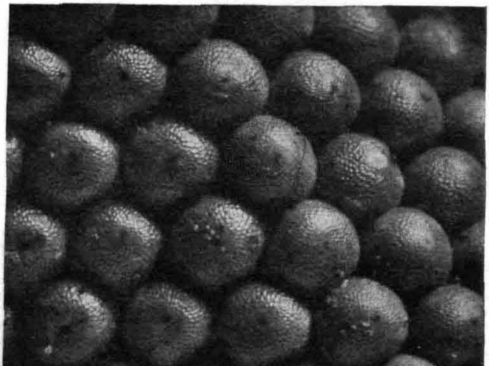


FIG. 548.—Egg mass of the acræa moth, *Estigmene acræa* (Drury), on a beet leaf. Eggs of same enlarged to show sculpturing on the surface. (Photos furnished by F. H. Wymore.)

The Virginia tiger moth or yellow bear, *Diacrisia virginica* (Fabr.) (*Spilosoma*),[1] has a wing expanse of 38–50 mm., is white with a black discal spot on each fore wing and often submarginal black spots on the hind wings; the abdomen yellowish brown with black dorsal and lateral spots; the front coxæ and femora yellowish brown or orange. The mature caterpillars measure as much as 40–50 mm., are very hairy, and are usually yellow or straw color with a black interrupted line on each side and a short black transverse line between each segment. The cocoons are oval and largely composed of body hairs. There are two broods, the caterpillars of the first reaching maturity in July and August and those of the second brood in the middle of September and October. The winter is passed in the pupal stage. They are general feeders and when

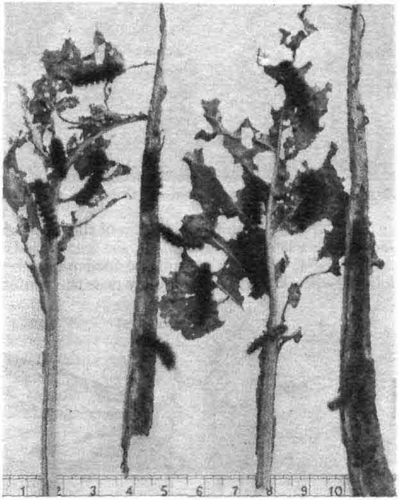


FIG. 549.—Caterpillars of the acræa moth, *Estigmene acræa* (Drury), feeding on tops of sugar beets. These hairy black and reddish larvæ are called woolly bears and salt marsh caterpillars.

abundant are serious pests to many crops. Among the known hosts are alfalfa, asparagus, beans, beets, blackberry, cabbage, canna, carrot, cauliflower, celery, cherry, corn, cotton, currant, dahlia, dock, eggplant, gooseberry, grape, hollyhock, lambsquarters, lilies, melons, morning glory, parsnip, peanut, peas, pigweed, potato, pumpkin, radish, ragweed, raspberry, rhubarb, Russian thistle, Spanish needle, squash, sunflowers, sweet potato, and turnips. Pupation occurs in a tough cocoon of hairs and silk, and the winter is passed by the pupæ of the second brood. The moth occurs throughout the country and in practically all the Western States, being common in Colorado, Utah, California, Oregon, Washington, and British Columbia.

The Isabella tiger moth or banded woolly bear, *Isia isabella* (A. & S.) (*I. californica* Pack.), has a wing expanse of 45 mm., is dull orange-yellow,

[1] H. O. Marsh, Bul. 82, pt. 5, Bur. Ent. U. S. Dept. Agr., p. 59, 1910.

with a few dusky spots on the fore wings and but two on the hind wings, and three rows of dark spots on the abdomen. The densely hairy larvæ are bright cinnamon red in the middle and black at both ends, or entirely brown,

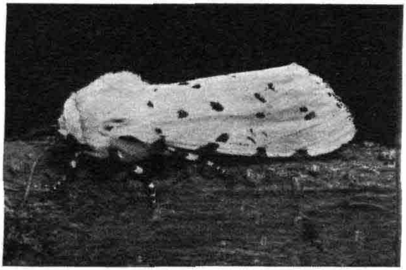


FIG. 550.—The acræa moth, *Estigmene acræa* (Drury), in natural attitude.

and are known as hedgehog caterpillars, because of the habit of rolling into a ball when disturbed or when hibernating. Their feeding habits are similar to those of the preceding species, the normal food plants being plantain, grasses, dandelion, burdock, and weeds. They pass the winter in protected

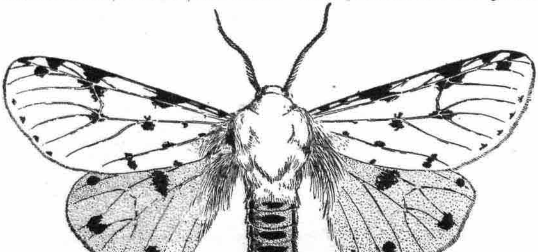


FIG. 551.—The acræa moth, *Estigmene acræa* (Drury), with wings spread to show body markings. (After Woodworth.)

places and pupate the following spring. The species occurs throughout the country.

The acræa moth, *Estigmene acræa* (Drury) (Figs. 548–551), is very similar in habits to the two preceding species. The adults have a wing expanse of 50–65 mm. The females are all white excepting the orange abdomen which has black lateral and dorsal spots and black spots on the wings. The hind

wings of the males are orange instead of white. The adults appear in the late spring and early summer and lay the somewhat flattened, spherical, pearly white eggs in masses on the food plants. The larvæ are known as salt marsh caterpillars and are very hairy and gray in the immature stages, and black with yellow broken lines and cinnamon red hairs on the sides. They become most abundant in September and October and may be as numerous as armyworms and equally as destructive, or perhaps more so, because of their large size, often measuring 50 mm. in length. It is a common sight to see them crossing the highways in great numbers during the fall of the year. They feed on everything available. The writer has seen them very destructive to sugar beets and beans, but they have also been taken on flowers, vegetables, field and forage crops, grasses and weeds. The winter is passed in the mature larval stage and pupation occurs in a brownish cocoon the following spring. The species is very common throughout the whole country.

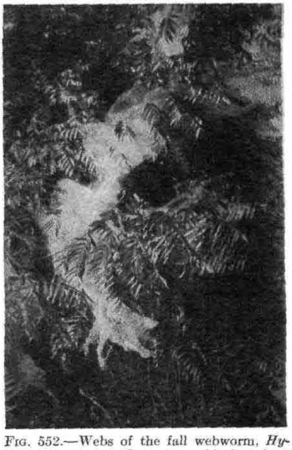


FIG. 552.—Webs of the fall webworm, *Hyphantria cunea* (Drury), on black walnut tree. (Photo by J. F. Lamiman.)

The fall webworm, *Hyphantria cunea* (Drury) (Figs. 552, 553), has a wing expanse of 50–60 mm., is pure white, clothed with long soft hair, with or without a few black spots on both side of the wings, the antennæ black and white, the abdomen often yellow with dorsal and lateral black spots, and the front coxæ and femora orange or bright red. The globular white or golden yellow eggs are laid in large masses usually on the undersides of the leaves in June and July and hatch in about ten days. The caterpillars spin large webs within which they feed. These webs are extended from time to time until they may enclose entire branches. The mature caterpillars are 25 mm. long, pale yellowish brown or grayish, clothed with long whitish hairs arising from black and orange tubercles. There is usually a yellow stripe along each side and a dusky one along the back. Maturity is reached in the fall, and the winter is passed as pupæ within dark brown cocoons attached to the tree trunks or in any secluded place. The caterpillars are gregarious and feed on many forest, shade, and ornamental deciduous trees and shrubs, and various cultivated plants. Willows, black walnuts, and cottonwood are often seriously infested in the west. The species also commonly invades orchards feeding on apple, cherry, peach, pecan, English walnut, and so forth. Cotton and hops are also attacked in California and Arizona. The distribution embraces practically all the west, the species being recorded in New Mexico, Arizona,

Colorado, Nevada, California, Oregon, Washington, Idaho, and British Columbia. **The spotless fall webworm,** *Hyphantria textor* (Harris), has white antennæ and spotless abdomen and is considered but a variety of the

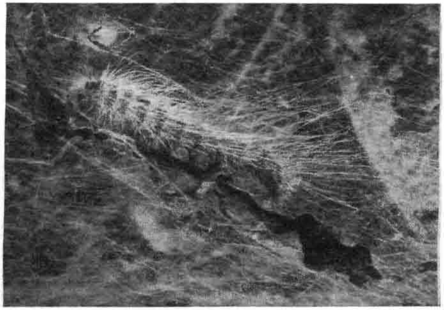


FIG. 553.—Larva of the fall webworm, *Hyphantria cunea* (Drury), feeding at edge of nest.

above by some workers. Its range, habits, and natural enemies are all practically the same.

The painted desert moth, *Arachnis picta* Packard, has a wing expanse of 40 mm., the wings are marbled gray and whitish above with orange or yellow spots on the undersides of the fore wings and red spots on the hind wings. The abdomen is red and black above and gray beneath. The caterpillars are densely clothed with black and brown hairs and at times appear in countless numbers in the arid regions of Mexico, Southern California, Arizona, New Mexico, and Colorado, and defoliate lupines, roses, sagebrush, and many other plants.

AGARISTIDÆ. Wood Moths, Foresters.

The eight-spotted forester, *Alypia octomaculata* (Fabr.),[1] is a velvety black moth, each fore wing with two large yellow spots and each hind wing with two white or cream spots, and an expanse of 30–33 mm. They appear in May and July. The caterpillars are 35 mm. long when mature, bluish brown, the head and shield bright orange with black spots; each segment banded white and orange or reddish, the eleventh with a prominent hump; the true legs black and prolegs orange. They commonly feed on wild and cultivated grapes and Virginia creeper throughout the east and range west into Colorado.

NOCTUIDÆ.[2] Noctuid Moths, Millers, Cutworms, Armyworms, Owlet-Moths.

This is a large family of very injurious species. The adults are of medium size and sombre yellow, tan, gray or brown colors, some with brightly colored hind wings.

They are night fliers, many being attracted to lights and commonly known as millers. The eggs are laid on the ground or host plant usually in the

[1] C. P. Gillette and G. M. List, Bul. 210, Colo. Agr. Exp. Sta. 1915.

[2] J. B. Smith, *Contrib. towards a Monograph of Noctuidæ*, etc. Bul. 38, U. S. Nat.

early spring. The larvæ (Fig. 532) are naked, smooth, with very few inconspicuous hairs, usually striped or mottled, normally with five pairs of prolegs, which may be reduced to three or four pairs in the semi-loopers. They are nocturnal and have variable habits, the cutworms living in the soil and feeding on the roots or cutting off plants at the surface. The climbing cutworms ascend plants and trees for feeding purposes; the green fruit worms attack developing fruits; the armyworms appear in countless numbers and devastate everything in their path; the stalk borers infest stems of grasses and other plants; the semi-loopers feed on truck and forage crops; and the afterwings and dagger caterpillars feed largely on the leaves of trees, and so forth. Maturity is reached by late summer or fall. Pupation usually occurs as a naked chrysalis in a cell in the soil. Hibernation occurs as immature caterpillars or as pupæ in the soil. There are one or several broods a year. The larvæ are heavily preyed upon by natural predaceous and parasitic insects consisting chiefly of the predaceous ground beetles, tachina flies, and hymenopterous parasites. Artificial control measures are summarized as follows:

1. Rotation of crops.
2. Clean culture in the fall and winter to eliminate egg laying on weeds and volunteer plants.
3. Fall and winter plowing to prevent egg laying and to kill hibernating forms.
4. Light traps to capture adults.
5. Running poultry and hogs over infested fields to destroy worms and pupæ.
6. Poison baits to be broadcasted over infested fields.

Formula

	Small Lots	Large Lots
Wheat Bran or Alfalfa Meal	6¼ pounds	50 pounds
Paris Green or White Arsenic	¼ pound	2 pounds
Blackstrap Molasses	½ pint	2 quarts
Water	½ gallon	2–4 gallons

7. Arsenical spray, 2 pounds of powdered arsenate of lead to 50 gallons of water.
8. Trenches to capture armyworms; drag log through to keep open and kill the caterpillars.
9. Irrigation where possible to stimulate growth and drown worms.

More specialized forms of control will be listed under the species.

The corn earworm or cotton bollworm, *Heliothis obsoleta* (Fabr.) (*Chloridea*)[1] (Figs. 554, 555), is one of the most common and injurious pests throughout the entire country. The adults have a wing expanse of 35–45 mm., and are fawn colored with darker spots on the fore wing and a brown

Mus., p. 237, 1890. Bul. 44, U. S. Nat. Mus., 1893. "*Noctuidæ* of California." *P. C. Jour. Ent.*, I, 1910, p. 179; II, 1910, p. 275; III, 1911, p. 558.

A. Gibson, *Cutworms and Armyworms*. Div. Ent. Dom. Dept. Agr. Canada. Bul. 70, 1912; 10, 1915.

Wm. T. M. Forbes, "A Table of the Genera of *Noctuidæ* of Northeastern N. A." *Jour. N. Y. Ent. Soc.*, 22, 1914, p. 1.

W. R. Walton, "Cutworms." *Farmers' Bul.* 739, U. S. Dept. Agr. 1920.

[1] A. L. Quaintance and C. T. Brues, *The Cotton Bollworm*. Bul. 50, Bur. Ent. U. S. Dept. Agr. 1905.

F. C. Bishopp, "The Bollworm or Corn Earworm." *Farmers' Bul.* 872. U. S. Dept. Agr. 1922.

W. J. Phillips and K. M. King, "The Corn Earworm." *Farmers' Bul.* 1310, U. S. Dept. Agr. 1923.

margin and transverse brown band on each hind wing. They are nocturnal and emerge from overwintering pupæ in April, May, and June. The small somewhat flattened round eggs are white or pale yellow, longitudinally ribbed with fine crosslines, and are laid on the food plants in May and throughout the summer and fall. On corn they are deposited usually on the silk. The mature caterpillars are familiar to all, averaging from 35–45 mm. in length, and are yellowish with purplish or brownish dorsal and

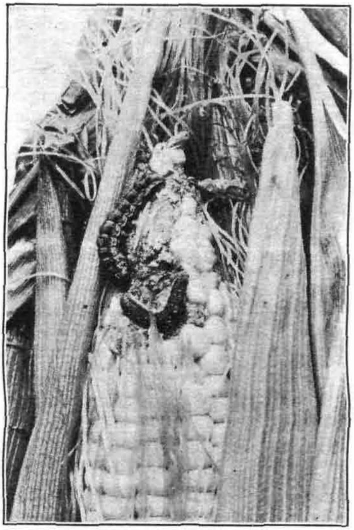


FIG. 554.—Larvæ of the corn earworm or cotton bollworm, *Heliothis obsoleta* (Fabr)., and characteristic work on ear of sweet corn.

subdorsal stripes. They are commonly called corn earworms because of the injury to green corn on the cob. Sweet corn is seriously damaged in this way and in some localities it cannot be successfully raised because of the inroads of the caterpillars. The name cotton bollworm is given because of the injury to the green bolls of cotton wherever this crop is grown, while that of green tomato worm is given because of the very common attacks on the green fruits of tomato. In addition to these crops, the caterpillars feed on alfalfa, globe artichokes, the developing pods of beans, cabbage, chick pea, clover, geranium, gladiolus, grape, hemp, henbane, malva, melilotus, mignonette, millet, okra, peach, pea, peanuts, pear, pepper,

pumpkin, rice, roses, squash, strawberry, sunflower, tobacco, and hairy vetch. Pupation occurs in the soil about the bases of the plants. A complete life cycle requires about 35 days in summer, there being three or more

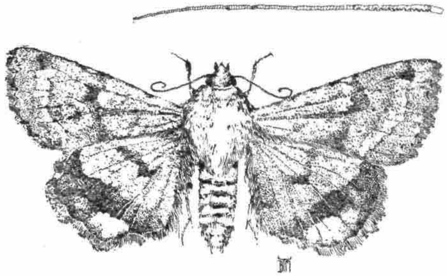


FIG. 555.—Adult of the corn earworm or cotton bollworm, *Heliothis obsoleta* (Fabr.).

broods annually. The winter is spent as pupæ in the soil. The insect is cosmopolitan in distribution, occurring throughout much of the tropical and temperate regions of the world. It is known in every Western State. Control measures are difficult. Crop selection is a very important item. The use of arsenical sprays and dusts has given some very good results on sweet corn if applied every seven or ten days when the ears are forming silk.

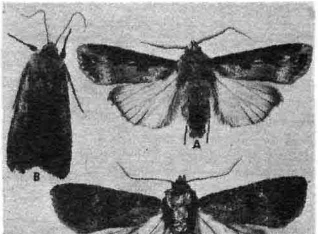


FIG. 556.—Common noctuid moths. A, the variegated cutworm, *Lycophotia margaritosa* (Haworth); B, the reaper dart, *Euxoa messoria* (Harris). (After Severin.)

The pale western cutworm, *Porosagrotis orthogonia* Morr.,[1] has a wing expanse of 38 mm., and is mottled gray. The adults are both nocturnal and diurnal, appear in late August and September, and deposit the whitish eggs in small batches in the soft soil about one-fourth inch deep, the newly cultivated fields being preferred. They hatch within a few days or not until the following spring. The winter, however, is usually spent in the immature larval condition. Mature larvæ are greenish gray with brown head and shield and small black spiracles. They feed until late June when they attain a length of 30 to 36 mm. Pupation

[1] J. R. Parker, A. L. Strand and H. L. Seamans, "The Pale Western Cutworm." *Circ.* 94, Mont. Agr. Exp. Sta. 1920. *Jour. Agr. Research*, 22, p. 289, 1921.

occurs two or three inches in the soil. There is but a single brood a year. The caterpillars often appear in countless numbers and attack the plants below the surface of the soil, feed day and night, and are specially injurious to winter and spring wheat, but infest wild grasses, alfalfa, barley, beets, cabbage, carrots, flax, oats, onions, and weeds. The species is most serious as a pest in Montana and Alberta, but ranges in North and South Dakota, western Kansas and Nebraska, Wyoming, Colorado, Utah, New Mexico, Arizona, and captures have been made in Nevada and California. Summer fallow offers the best means of control, but fair results are obtained by late plowing after the middle of September. The adults are effectively trapped by lights. *Porosagrotis vetusta* (Walker) is gray with a pinkish tinge and the caterpillars pale pinkish with dark tubercles. They attack field, truck, forage, and cereal crops. The range includes much of the country. The species is known in Colorado, Arizona, California, and British Columbia in the west.

The reaper dart, *Euxoa messoria* (Harris) (Fig. 556, B), has a wing expanse of 35–40 mm. and is silvery gray with dark mottled fore wings. It is very common throughout the United States and is always abundant in the summer and fall along the Pacific Coast in California, Oregon, Washington, and British Columbia. The dull, pale green larvæ attack wild grasses, weeds, and cultivated crops, and may be present in great numbers. *Euxoa excellens* (Grote) is similar to the preceding species and is often common and destructive to truck and forage crops in the Western States. It ranges from the Rocky Mountains to the Pacific Ocean and north into British Columbia.

The red-backed cutworm, *Euxoa ochrogaster* (Gn.), is variable in color from light fawn to uniform dark brown. The cutworms are characterized by the reddish color on the dorsum. They feed on succulent plants and are very destructive to cereal, forage, and truck crops. In many parts of the country this is the most regular and destructive species. In the west it has been injurious in Montana and British Columbia. It readily takes the poison bran mash. E. H. Strickland [1] recommends shorts in place of bran for this species.

The western armyworm, *Chorizagrotis agresits* (Grote) (*Euxoa*),[2] has a wing expanse of 32 mm. and is dark brown with gray markings on the fore wings. The armyworms are pale green to dark brown with dark stripes on the sides, and attain a length of 50 mm. when mature. They commonly appear in small, though occasionally in enormous numbers, and travel in armies, devastating everything green in their path, including native grasses and weeds, truck, forage and cereal crops, cotton, forest, and fruit trees. It is a western species ranging from the Rocky Mountains to the Pacific and from Mexico into Montana.

The army cutworm, *Chorizagrotis auxiliaris* (Grote),[3] is similar to the preceding one in habits and destructiveness, and the life history of each is much like that of the pale western cutworm previously described. The mature caterpillars are dark with a broad pale line down the back, a dark stripe on each side, and are 40–50 mm. long. They may appear in armies and attack all kinds of green vegetation. It has practically the same distribution as the western armyworm.

The granulated cutworm, *Feltia annexa* (Treitschke), is brown, the fore wings grayish, pale at the tips and in the subcostal area, and the hind

[1] *Can. Ent.*, 47, p. 203, 1915.
[2] R. A. Cooley and J. R. Parker, *Circ.* 52, Mont. Agr. Exp. Sta. 1916.
[3] R. A. Cooley, *Circ.* 4, Mont. Agr. Exp. Sta. 1910. *Jour. Agr. Research*, 6, p. 871, 1916. C. P. Gillette. Bul. 98, Colo. Agr. Exp. Sta., p. 19, 1905.

wings whitish. The caterpillars are 25 mm. long, smooth, dark gray with many black granules over the surface. They live in the soil and cut off the plants below the surface. Cereal, field, forage and truck crops are attacked. The species ranges from South America into much of the United States and occurs as a pest to alfalfa and other crops in Arizona and California.

The greasy cutworm, *Agrotis ypsilon* (Rottemburg), has a wing expanse of 33 mm., the color is dull reddish or brownish gray with silvery patches at the bases and tips of the fore wings, and the hind wings and abdomen are silvery gray. The caterpillars are dull brown to nearly black with a broken pale yellowish line on the dorsum and two faint lines on each side. The whole surface is shiny and greasy in appearance. They are general feeders and particularly destructive to succulent truck and forage crops. The species is cosmopolitan and occurs throughout the country and the west.

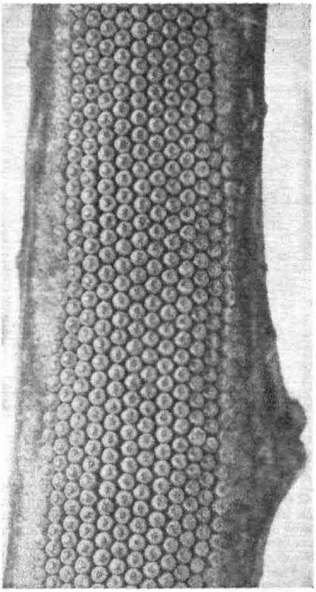


FIG. 557.—Egg mass of the variegated cutworm, *Lycophotia margaritosa* (Haw.), on peach twig. The radiating sculpturing is a distinguishing characteristic.

The variegated cutworm, *Lycophotia margaritosa* (Haworth) (Figs. 556, A; 557, 558), is a grayish brown moth with dark mottled fore wings, a brassy lustre, and a wing expanse of 40–50 mm. The eggs are very small, flattened, spherical, white to dull lead color, distinctly and minutely ribbed. They are laid in rows in large irregular masses on the foliage and stems of plants, the limbs and trunks of trees, and other convenient places in the early spring. The caterpillars are general and destructive feeders on all kinds of vegetation and can be serious pests to forage, cereal and truck crops, flowers, fruit, shade, ornamental and forest trees. When mature they are 40–45 mm. long, variable in color but usually gray or brown mottled above with gray or darker lines, and often with oblique gray areas on the sides. This is perhaps the most widely known and important cutworm, being cosmopolitan in distribution and a pest in many countries. It is very common throughout the entire west. The fungus, *Empusa aulicæ* (Reichardt), kills the larvæ in many localities in the spring.

The striped beet caterpillar, *Scotogramma trifolii* (Rott.)[1] (*Mamestra*)[2], is uniform or mottled ashy gray to luteous gray, with a wing expanse of 30–37 mm. The eggs are white or yellow, hemispherical, ribbed, and laid singly on the undersides of the leaves in the early spring and during the summer. The mature caterpillars are 33 mm. long, dull green with a pinkish stripe along each side. They feed on succulent plants and are injurious to sugar beets, weeds, truck, and forage crops. There are two or three broods a year. The species occurs in Europe and North America and is

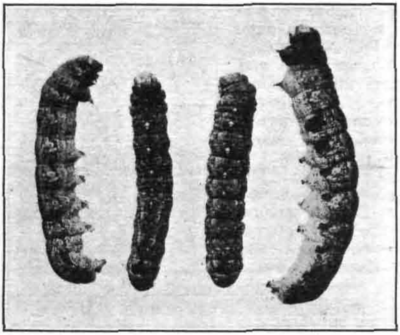


FIG. 558.—Larvæ of the variegated cutworm, *Lycophotia margaritosa* (Haw.).

recorded in Colorado, New Mexico, Arizona, California, Oregon, Washington, and British Columbia in the west.

The olive green cutworm, *Neuria procincta* (Grote) (*Dargida*), has a wing expanse of 45 mm., is dark brown with olive tints, and with cream cross and longitudinal lines on the fore wings. The mature caterpillars are 30–35 mm. in length, dark olive green with a pale dorsal line and three greenish lateral lines separated by brownish gray. They are often serious pests to wild and tame grasses in meadows and pasturelands in Oregon, Washington, and British Columbia, but are also known in California and Colorado.

The brassy cutworm, *Eriopyga rufula* (Grote) (*Tæniocampa*), has a wing expanse of 25–30 mm. and is brassy fawn colored with a darker brownish spot near the middle of each fore wing. The caterpillars are brassy in appearance and may ascend trees and attack the green fruit of apple, apricot, peach, pear, and plum. The species is known in California and Colorado and probably occurs in other Western States.

The armyworm, *Cirphis unipuncta* (Haworth)[3] (*Heliophila*) (Fig. 559), has a wing expanse of 30–35 mm., and is silvery gray or fawn colored with

[1] H. O. Marsh, Bul. 127, pt. 2, Bur. Ent. U. S. Dept. Agr. 1913.

[2] J. B. Smith, "Revision of the Genus *Mamestra*." *Proc. U. S. Nat. Mus.*, 14, p. 197, 1891.

[3] Arthur Gibson, *The Army-Worm*, Bul. 9, Ent. Branch Dom. Can. Dept. Agr. 1915. D. G. Tower, "Amount of Food of Parasitized and Nonparasitized Larvæ." *Jour. Agr. Research*, 6, p. 455, 1916. W. R. Walton, "The True Army Worm and its Control." *Farmers' Bul.* 731, U. S. Dept. Agr. 1916. John J. Davis and A. F. Satterthwait, "Life History of the True Army Worm." *Jour. Agr. Research*, 6, p. 799, 1916.

fine dark spots on both sides of the wings and a single distinct white spot near the middle of each fore wing from which the specific name is derived. The adults begin to appear in the spring and continue throughout the summer and fall, there being three or four broods a year. The eggs are nearly spherical, smooth, white or yellowish, smaller than a pin head, and usually laid in rows or masses in the folded blades or under the leaf sheaths of grasses and grains in the spring and during the summer and fall. They hatch in 8 or 10 days. The caterpillars mature in three or four weeks and are 18–25 mm. long, smooth, greenish, dark gray or dusky, with three yellowish stripes on the dorsum, and a broad darker yellow stripe on each side. They are often exceedingly numerous and prefer wild and cultivated grasses, cereals, and similar plants, but also attack forage, field, and truck crops. The winter is passed in the immature larval stages. The species is widespread throughout the world and occurs in all parts of North America. It is common in the west.

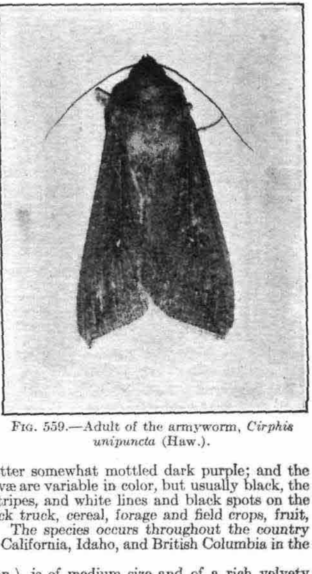


FIG. 559.—Adult of the armyworm, *Cirphis unipuncta* (Haw.).

The wheat head armyworm, *Neleucania albilinea* (Hbn.),[1] is a pale fawn and white moth, the fore wings with a broken brown line lengthwise across the middle. The caterpillars are serious pests to the heads of wheat, oats, barley, timothy, and other cereals and grasses. They also feed on the leaves. There are two broods. The species occurs in the Eastern States and ranges west into Colorado, New Mexico, and Arizona.

The zebra caterpillar, *Ceramica picta* (Harris) (*Mamestra*), has a wing expanse of 35–40 mm.; the head, thorax, and fore wings are reddish brown, the latter somewhat mottled dark purple; and the abdomen and hind wings whitish. The larvæ are variable in color, but usually black, the head reddish and the body with yellow stripes, and white lines and black spots on the sides. They are general feeders and attack truck, cereal, forage and field crops, fruit, forest, and ornamental trees, and weeds. The species occurs throughout the country and is known in Colorado, Utah, Nevada, California, Idaho, and British Columbia in the west.

The fern moth, *Euplexia lucipara* (Linn.), is of medium size and of a rich velvety maroon, mottled gray color, the caterpillars are green and match the color of ferns upon which they feed. This is a European species which infests ferns in greenhouses and residences in various parts of the United States. It was taken in California in 1922 by the author, and is often destructive in the San Francisco Bay region.

The cotton cutworm, *Prodenia ornithogalli* Guenée, has a wing expanse of 38 mm., the fore wings are mottled gray, brown, and of various colors, and the hind wings and abdomen are pale. The caterpillars are olive brown with a greenish cast, fine longitudinal gray lines, and a double row of velvety green or black spots on the dorsum. They attack truck and field crops, flowers, fruit, forest, and shade trees, and are often

[1] R. L. Webster, *Jour. Econ. Ent.*, 4, p. 179, 1911; 5, p. 335, 1912.

a pest to the bolls of cotton in Mexico, Southern California, Arizona, and New Mexico. The species ranges east into the Atlantic States.

The yellow-striped armyworm, *Prodenia præfica* Grote (Fig. 560), has a wing expanse of 35–40 mm., is gray or brown, the fore wings mottled with slate colored and buff markings, the hind wings silvery and gray. The mature caterpillars measure 35–50 mm., are velvety black on the dorsum with two prominent and many fine bright yellow stripes on the sides, and reddish beneath. They are general feeders and have been serious pests to alfalfa in the central valleys of California. They also infest truck crops, melons, grapevines, weeds, and cotton. Serious outbreaks have occurred in California in 1915, 1918, and 1922.

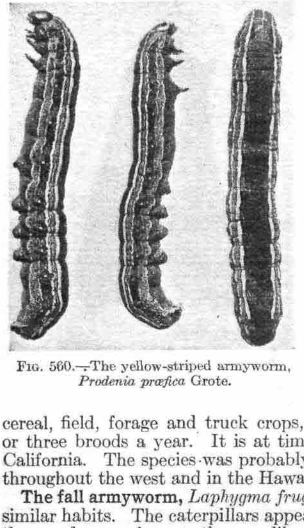


FIG. 560.—The yellow-striped armyworm, *Prodenia præfica* Grote.

The beet armyworm, *Laphygma exigua* (Hbn.) (*Caradrina flavimaculata* Harvey), is one of the commonest pests in the west. The adults are mottled gray or dusky with distinct paler markings on the fore wings, and an expanse of 25–30 mm. They appear in the spring and deposit the pale greenish or pinkish striated eggs in small or large masses, covered with a white cottony material on the host plants. The larvæ attain a length of 35 mm., are pale or olive green above with a dark dorsal stripe and a yellow subdorsal stripe on each side, and the entire ventral half pale yellowish. They often appear in countless numbers and have been particularly injurious to sugar beets, destroying not only the tops, but the roots as well. They also feed on cereal, field, forage and truck crops, weeds, and grasses. There are two or three broods a year. It is at times a serious pest to young cotton in California. The species was probably introduced from Europe and occurs throughout the west and in the Hawaiian Islands.

The fall armyworm, *Laphygma frugiperda* (A. & S.), is a like species with similar habits. The caterpillars appear every year in some areas and while they prefer cereal crops, they readily attack forage and truck crops, weeds, fruit, ornamental and forest trees. There are two or three broods a year and the winter is spent in the chrysalis and adult stages. The species ranges from South America into the northern part of the United States, and occurs in the Western States of New Mexico, Colorado, Wyoming, and Montana.

The stalk borer, *Papaipema nebris* (Gn.), bores the stalks of celery and different weeds in British Columbia. The larvæ of *Cea cirphidia* Hamp. (Fig. 561) infest the stems of wild rye in Southern California. *Luceria tranquilla* (Grote) infests elder in California.

The moths of the genus *Catocala* are mostly mottled gray to match the bark of deciduous trees, but have showy red or orange hind wings which are usually bordered and banded with black. The caterpillars of *C. aholibah* Strecker are brownish with black specks and reddish tubercles encircled with white, pink legs, and white venter. They feed on the catkins of oaks in the Pacific States and east into Colorado. The larvæ of *C. aspasia* Stkr. feed on poplars and cottonwoods in Utah and Colorado. The larvæ of *C. californica* Edw. are purplish brown with black, orange, and reddish stripes and markings, 60 mm. long when mature, and feed on willows in California.

The alfalfa semi-looper, *Autographa californica* (Speyer) (*Plusia*, *Phytometra*)[1] (Fig. 562), has a wing expanse of 30–40 mm.; the fore wings are gray with a silver "gamma" mark near the middle of each, the hind wings and the body dull gray or brown. The semi-looper appears in the spring and throughout the summer, and visits flowers at dusk and the early part of the night. The pale yellow, hemispherical eggs are laid on the host plants. The mature caterpillars are 25 mm. long, dark olive green

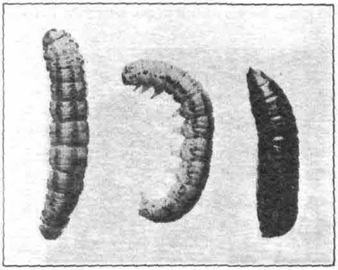


FIG. 561.—Larvæ and pupa of *Cea cirphidia* Hampson. A common cutworm which works within the stems of wild rye in Southern California.

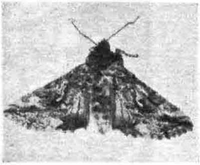


FIG. 562.—Adult of the alfalfa semi-looper, *Autographa californica* (Speyer).

with paler head, with dark dorsal and two subdorsal lines, and with but two pairs of prolegs behind the middle and a single pair at the extreme posterior end. They move in a looping fashion. They are very general feeders and are responsible for serious damage to alfalfa and to other forage crops as well as to cereals, truck crops, flowers, weeds, fruit, ornamental and forest trees, and shrubs. The winter is passed in the pupal and adult stages and there are two broods, the adults of the second appearing in July. The species occurs throughout the west, having been recorded in all the States excepting Arizona and New Mexico. **The cabbage looper,** *Autographa brassicæ* (Riley), is a similar species which is common throughout the entire country and is usually confused with the preceding one. The caterpillars are specially fond of cabbage and other cruciferous plants, but are also general feeders. **The celery looper,** *A. falcifera* (Kirby) (*Plusia simplex* Gn.), is much like the two preceding species, but large with purplish brown fore wings which are not scalloped. The pale green larvæ feed on celery, sugar beets, lettuce, and succulent weeds and plants throughout the United

[1] J. A. Hyslop, Bul. 95, pt. 7, Bur. Ent. U. S. Dept. Agr., p. 109, 1912.
L. Childs, *Second Bien. Crop Pest and Hort. Rept.* 1913–1914, Ore. Agr. Exp. Sta., p. 184, 1915.

States and the west. **The cotton leaf worm,** *Alabama argillacea* (Hbn.), is a very common species infesting cotton in the Southern States. It ranges west into New Mexico, Arizona, and Southern California.

The giant noctuid, *Erebus odorata* (Linn.), is a huge dark brown moth having a wing expanse of 160 mm. The fore wings are marked with an eye spot shaped like a comma near the middle and the hind wings each have a large double eye spot near the anal angle. The female has a double irregular white band across the middle of both pairs of wings, which is wanting in the male. This moth is a tropical species which ranges northward from South and Central America. Adults are frequently taken as far north as Berkeley, California, and in Arizona and New Mexico, and occasionally in Colorado and Utah.

DIOPTIDÆ. Oak Moth.

The California oak moth, *Phryganidia californica* Packard [1] (Figs. 563–566), has a wing expanse of 25–35 mm., is of a uniform pale brown through-

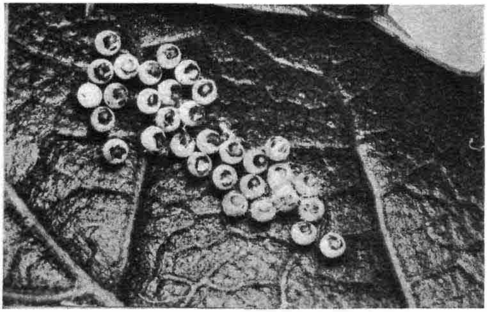


FIG. 563.—Eggs of the California oak moth, *Phryganidia californica* Packard, on leaf of coast live oak.

out, with the antennæ and wing veins slightly darker. The males have pectinate antennæ and faint yellowish patches near the middle of each fore wing. The eggs are nearly spherical, slightly flattened above, 1 mm. in diameter, first white and changing to yellow, brownish, and pinkish gray as the embryos develop. They are laid singly or in masses on the leaves, limbs, and elsewhere on the hosts and other trees and shrubs. They hatch in from 10–15 days. The caterpillars molt about five times. When mature they are 25 mm. long, olive green with black and prominent yellow longitudinal stripes on the dorsum and sides, and with brown or reddish head. The pupæ or chrysalids are 12–14 mm. long, shining, smooth, whitish or yellowish with black markings. They are suspended by the posterior end to the leaves, limbs, or trunks of the trees or to any convenient object nearby. There are two broods annually. The adults which appear in October and November, immediately lay eggs, most of which hatch before winter, but

[1] H. E. Burke and F. B. Herbert, *Farmers' Bul.* 1076, U. S. Dept. Agr. 1920.

some remain on the trees and do not hatch until the following spring. On the live oak trees the immature caterpillars pass the winter in a more or less active feeding condition, while all perish on the deciduous oaks when the leaves fall; a few eggs, however, survive on old leaves which do not fall, a fact which accounts for caterpillars appearing on the deciduous oaks

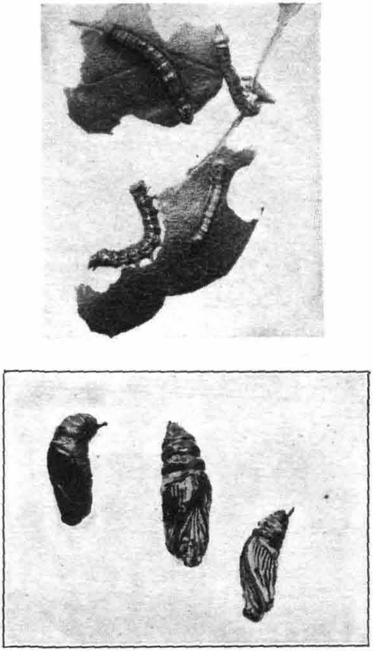


FIG. 564.—Caterpillars and chrysalids or pupæ of the California oak moth, *Phryganidia californica* Packard. The caterpillars are feeding on oak leaves.

when the new growth comes out in the spring. This winter brood of caterpillars matures in May and June and after pupation the moths emerge in June and July and lay their eggs on all kinds of oak trees. They hatch in a short time and give rise to the summer brood, the adults of which appear in October and November, thus completing the yearly cycle. The caterpillars are present in few or large numbers every year, but are seriously

FIG. 565.—Adults of the California oak moth, *Phryganidia californica* Packard, in natural repose on the bark of an oak tree.

FIG. 566.—Oak trees near Palo Alto, California, defoliated by the caterpillars of the California oak moth, *Phryganidia californica* Packard. The trees at the left were only partially defoliated when the photo was taken.

destructive only at long, irregular intervals, when they often completely defoliate the largest trees over extensive areas. All varieties of oaks and, rarely, chestnuts, eucalyptus, and other trees are attacked. The species occurs in many parts of California, but is most destructive in the San Francisco Bay region. That the moth is not regularly a pest is probably due to the very efficient work of natural enemies. A bacterial wilt disease kills many of the caterpillars. Artificial control can best be effected by spraying the trees in spring with 3 pounds of powdered arsenate of lead to 100 gallons of water, to kill the overwintering and newly hatched larvæ and thus cut down the summer brood. The spray, however, can be effectively used at any season.

NOTODONTIDÆ. The Prominents.[1]

The yellow-necked caterpillar, *Datana ministra* (Drury) (Fig. 567), has a wing expanse of 35–45 mm., the bodies are dark brown, the fore wings cinnamon brown with three or four darker lines across each, and the hind wings pale yellowish. The species is single brooded, the winter being spent in the pupal stage in the soil. The adults appear in the spring and lay the ovate white eggs in masses of 25–50 on the undersides of the leaves. The mature caterpillars are 55 mm. long, have a black or dark red head, bright yellow or orange prothoracic shield or neck, black body clothed with fine long whitish hairs and with four bright yellow stripes on each side. They are gregarious and when disturbed the head and tail are thrown into the air, the body being supported by the middle prolegs. The very young caterpillars skeletonize the tender leaves, but after a week or so old they devour all but the stems and midribs. It is a common orchard pest attacking apple, apricot, cherry, chestnut, peach, pear, plum, quince, walnut and also blackberry, birch, hazel, hickory, oak, wild cherry, wild plum, hornbeam, black walnut, and many other forest and ornamental trees and shrubs. The species occurs throughout much of the United States and is known in California, Idaho, and British Columbia in the west. The use of arsenate of lead spray or dusts will easily control the caterpillars when young. *Datana robusta* Stkr. infests lemon berry or sumach in Southern California.

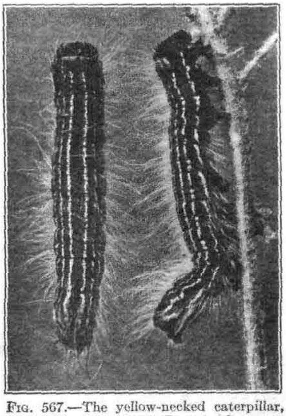


Fig. 567.—The yellow-necked caterpillar, *Datana ministra* (Drury). Larvæ.

The red-humped caterpillar, *Schizura concinna* (A. & S.) (Fig. 568), has a wing expanse of 30–35 mm. and is plain reddish brown or gray. The

[1] B. Neumogen and H. G. Dyar, "A Preliminary Review of the *Notodontidæ*." *Trans. Am. Ent. Soc.* 21, p. 179, 1894.

nearly spherical, pearly white eggs are laid in large masses on the undersides of the leaves in the spring. The full grown caterpillars are yellow or reddish and have six or eight dark tubercles on each segment, and the entire body lined with white, very dark reddish brown, red, and black lines. The head is bright red, as is also the fourth segment which is distinctly humped and on the top of which are two prominent black tubercles. The length varies from 25–35 mm. The reddish brown chrysalids are enclosed in a thin cocoon in a cell in the ground where the winter is spent. There are one or two broods annually. The caterpillars are gregarious and common orchard pests, appearing most abundantly in midsummer or later, and stripping the foliage of apple, apricot, aspen, birch, blackberry, cottonwood, cherry, hawthorn, huckleberry, pear, plum, poplar, prune, rose, willow, and black and English walnuts. The species occurs throughout the country and is recorded in California, Oregon, Washington, Idaho, Montana, and British Columbia in the west.

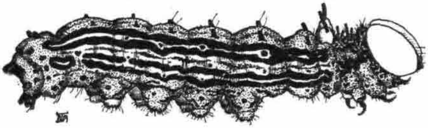


FIG. 568.—The red-humped caterpillar, *Schizura concinna* (A. and S.).

LYMANTRIIDÆ (*Liparidæ*). Tussock Moths.

The California tussock moth, *Hemerocampa vetusta* (Bdv.) [1] (Figs. 569-572), has a wingless gray female 12–15 mm. long and winged males having an expanse of 20–25 mm., brown with gray markings. The eggs are small, round, white, and laid in closely matted gray felty masses upon the old cocoons or the bark of the trunk or larger limbs. The full grown caterpillars are 13–25 mm. long, gray with numerous brightly colored red, blue, and yellow spots, four median and one posterior white dorsal tuft, and two long anterior and one posterior black horn-like tuft. These black tufts are responsible for the name, horned caterpillars. They feed on the leaves and young fruit of the apple and are accountable for much damage in many sections. The developing fruit heals over the injuries, causing very characteristic scabbing (Fig. 570) which ruins the market quality. The caterpillars also attack almond, apricot, blackberry, California Christmas berry, California coffee berry, cherry, hawthorn, lupines, manzanita, oaks, pear,

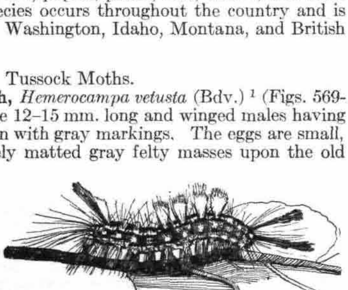


FIG. 569.—Caterpillar of the California tussock moth, *Hemerocampa vetusta* (Bdv.).

[1] W. H. Volck, Bul. 183, Cal. Agr. Exp. Sta. 1907.

plum, prune, walnut, and willows. There is but a single brood. The eggs are laid in late summer and fall, remain on the trees during the winter, and begin to hatch when the leaves unfold in the spring. The adults emerge in May, June, and July, mate and deposit their eggs, thus completing the life cycle. The species occurs along the Pacific Coast from Southern California into British Columbia. The variety *cana* (Hy. Edw.) occurs in the Sierras. Artificial control consists in the removal and destruction of the

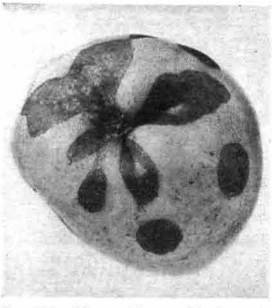


FIG. 570.—Mature Newton Pippin apple showing characteristic injury by the larvæ of the California tussock moth, *Hemerocampa vetusta* (Bdv.), when the fruit was very small.

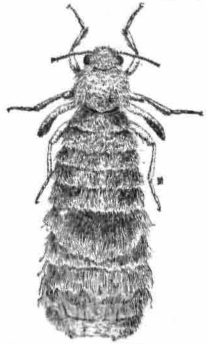


FIG. 571.—The California tussock moth, *Hemerocampa vetusta* (Bdv.). Adult female.

egg masses during the winter, jarring the caterpillars from the trees, and banding as suggested for cankerworms.

The oak tussock moth, *Hemerocampa gulosa* Hy. Edwards,[1] has usually been considered a race of the preceding species. The larvæ are distinguished by the often black-tipped dorsal tufts and the wholly black tuft on the eighth segment. The adult males are also larger and with more distinct markings. The caterpillars feed on oaks in the Sierras of California.

The fir tussock moth, *Hemerocampa pseudotsuga* McDunnough,[2] has also often been considered previously a variety of *H. vetusta* (Bdv.). The caterpillars are distinguished by the dorsal tufts and the abdominal segments of which one to four are whitish tipped with chestnut brown and the pencil or tuft on the eighth segment black tipped with chestnut brown. They feed on Douglas fir. The species commonly occurs in British Columbia.

The white marked tussock moth, *Hemerocampa leucostigma* (A. & S.), is the common tussock moth of the Eastern States. The male and female are much like the western species. The caterpillars are 30–35 mm. long, bright yellow, the head and two small tubercles on the posterior portion of the back bright coral red; four creamy dorsal tufts; two anterior and one posterior black plume; and black and yellowish stripes on the back and sides. The habits and life history are similar to the California tussock moth. It ranges west into Colorado and British Columbia and is very heavily parasitized in the east by a large number of tachina flies and hymenopterous parasites.[3]

[1] J. McDunnough, *Can. Ent.*, 53, p. 53, 1921.
[2] *Ibid.*
[3] L. O. Howard, *Tech. Ser.* 5, Div. Ent. U. S. Dept. Agr. 1897.

Oslar's tussock moth, *Hemerocampa oslari* (Barnes), commonly attacks fir trees in the high mountains of the Western States. In Colorado the caterpillars strip the tops of the fir trees destroying the seed crop, and also strip the tops of the white fir in the Sierras of Nevada and California.

The antique tussock moth, *Notolophus antiqua* (Linn.), has reddish brown wings in the male which have two dark transverse bands and a conspicuous white spot near

FIG. 572.—The California tussock moth, *Hemerocampa vetusta* (Bdv.). Adult male.

the anal margins of the fore wings. The females are yellowish to grayish black. The caterpillars resemble those of the other tussock moths, but have the first two dorsal tufts black in the younger stages which become lighter with age. The eggs are laid in large masses, one layer deep and without protective covering, usually on the old cocoons. The larval food consists of alder, apple, apricot, mountain ash, aspen, beech, birch, cherry, hawthorn, hazel, larch, oaks, pear, pine, poplar, plum, prune, quince, and willow. The species occurs in Europe and various parts of North America. In the west it is recorded in California, Oregon, Washington, British Columbia, Idaho, and Montana. This species is also known as the rusty tussock or vaporur moth.

FIG. 573.—Egg mass of the forest tent caterpillar, *Malacosoma disstria* Hbn., surrounding small apple twig. The eggs are covered with a waterproof cement to protect them during the winter.

The satin moth, *Stilpontia salicis* (Linn.),[1] has a wing expanse of 35–55 mm., is satinlike, white, often with yellowish, or in the male, blackish costal margin; head, collar and pectinatians of the antennæ dark; tibiæ and tarsi with wide black rings. The eggs are laid in clusters and cemented by a whitish secretion on the undersides of the leaves, on the branches and trunks of the trees, or on any convenient nearby object, during July and August. They hatch in a short time and the larvæ begin to feed on the leaves. They hibernate as immature brownish black caterpillars which have whitish spots on the back, are 6 mm. long, and covered with brown spines. Protection is afforded in crevices in the bark which are lined and covered with silk webbing. The caterpillars begin feeding in the spring and become full grown by the first of July. They are then 45-50 mm. long, blackish, mottled with irregular white markings in the form of subdorsal lines and a row of nearly square white blotches on the dorsum, and with brown spines and longer, paler hairs. They feed largely on

[1] A. F. Burgess, *Dept. Circ.* 167, U. S. Dept. Agr. 1921.

the foliage of poplars and willow, but are also recorded on oak in Europe, and often completely strip the trees. Pupation occurs in cocoons in the leaves or on the bark or nearby objects. There is but a single brood. The satin moth occurs in Europe and Siberia and was introduced into Massachusetts in 1920. A. L. Melander[1] recorded it in 1922 as established on poplar trees in northwestern Washington and just across the border in British Columbia. The infested areas are under Federal quarantine. Spraying in the spring with 5 pounds of powdered arsenate of lead and a spreader to 100 gallons of water is suggested as a remedy.

LASIOCAMPIDÆ.[2] Tent Caterpillars, Lappet Caterpillars, Lasiocampids.

The forest tent caterpillar, *Malacosoma disstria* Hbn. [*M. erosa* (Stretch)] (Figs. 573–575), is the most generally distributed species in the west. The

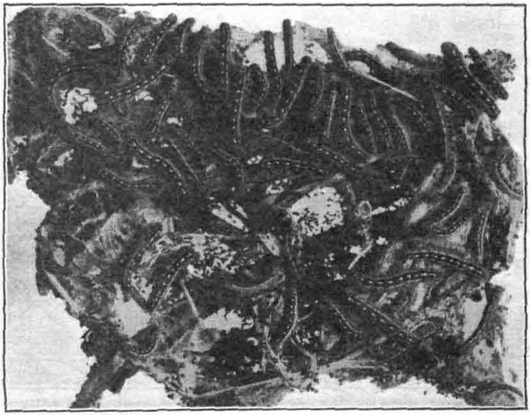


FIG. 574.—A group of forest tent caterpillars, *Malacosoma disstria* Hbn., resting on web on apple branch.

adults have a wing expanse of 20–35 mm. The color varies from a rusty red to pale fawn, the fore wings with two narrow, pale, oblique transverse lines separating off a wide dark band. The males are usually smaller and much darker than the females. The adults appear in early or mid summer and the females deposit the eggs in very characteristic rings around the small twigs of the trees and cover them with a silvery gray or dark cement. The tiny caterpillars form in late fall, pass the winter within the egg shells, and emerge when the leaves begin to unfold in the spring. The caterpillars

[1] *Insect Pest Surv. Bul.* Bur. Ent. U. S. Dept. Agr. 6, p. 223, 1922.

[2] J. M. Swaine, "Tent Caterpillars." *Ent. Cir.* 1, Div. Ent. Dom. Can. Dept. Agr. 1913.

are gregarious and live in large colonies. This species instead of building the large silken tents, collects in dense masses on the larger limbs and trunks of the host trees when not feeding. The caterpillars are dusky brown with fine yellowish brown dorsal and lateral stripes, a row of diamond or key-hole shaped white spots along the back, are clothed with long, fine brown hairs, and measure 45–55 mm. long when mature. They are voracious feeders and often strip the trees of the leaves and young fruit. Pupation occurs in a yellowish silken cocoon in any convenient place on the tree or nearby objects. There is but a single brood. The hosts include apple, birch, box elder, cherry, choke cherry, hawthorn, peach, pear, plum, poplars, prune, quince, roses, willow, and many other fruit and forest trees. This species

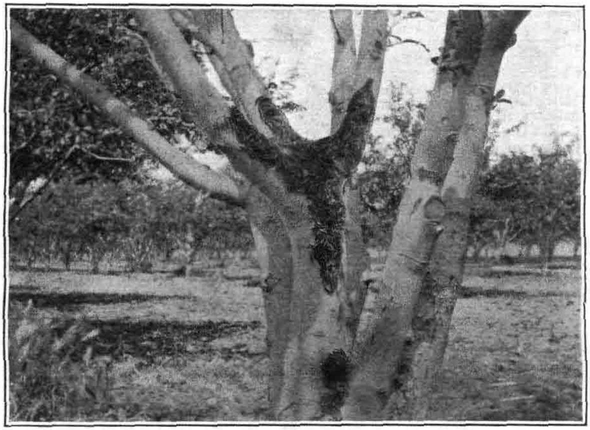


FIG. 575.—Colony of the forest tent caterpillar, *Malacosoma disstria* Hbn., resting on an apple tree.

is very common throughout the continent and occurs along the Pacific Coast chiefly in California, Oregon, Washington, and British Columbia, but is recorded also in Idaho, Montana, and other Western States. For control dust the young caterpillars with 5 per cent nicodust or with powdered arsenate of lead. In California a number of hogs were killed on the ranges in Mendocino County because they ate cocoons and pupæ of this moth which were very abundant in 1918.

The apple tree tent caterpillar, *Malacosoma americana* (Fabr.), is the well known eastern tent-making species. The caterpillars have a white dorsal line bordered with reddish brown, and a row of blue spots and reddish brown and yellow lines and markings on the sides. The caterpillars construct large webs in the early spring and feed on deciduous fruit, forest,

and ornamental trees and shrubs. The species ranges west into New Mexico, Colorado, Montana, Idaho, and British Columbia. The natural enemies are numerous and include those listed for the preceding species and many others.

The California tent caterpillar, *Malacosoma californica* (Pack.), is a common oak-infesting species in California. The caterpillars are reddish brown or tawny above and paler beneath, with a blue line on each side. They construct large tents in the spring and are common on almond, apple, apricot, ash, California Christmas berry, California coffee berry, ceanothus, cherry, cottonwood, currant, hazel, madrona, oak, plum, prune, red bud, willow, and other fruit and forest trees.

Malacosoma constricta (Stretch) has the body of the caterpillars orange brown, densely covered with blue on the sides, and subdorsal blue dots. It very closely resembles the preceding species and feeds on oaks, other native trees, and shrubs and fruit trees in Arizona, California, and Oregon.

The great basin tent caterpillar, *Malacosoma fragilis* (Stretch), is a common and often injurious species in the region between the Rocky Mountains and the east, and the Sierras and the Cascades, but extends over the west slopes of the latter into northern California and southern Oregon. The caterpillars are tawny with body black, head blue gray, broad pale blue dorsal stripe, fine orange subdorsal lines, two blue subdorsal spots on each segment, and the hair on sides whitish. They are omnivorous feeders, attacking and webbing chiefly ash, aspen, ceanothus, wild cherry, cottonwood, wild gooseberry, manzanita, oaks, wild plums, poplars, wild rose, and willow, and orchard trees when available. The species is often very abundant in higher altitudes. The eggs are laid in masses or in bands halfway around the twigs. The adults are pale yellow or ochre. The distribution includes New Mexico, Colorado, Wyoming, Montana, Utah, Nevada, California, and Oregon.

The coast tent caterpillar, *Malacosoma pluvialis* (Dyar), is a common species in the Pacific Northwest, ranging between the Sierras and Cascades to the ocean in northern California, Oregon, Washington, and British Columbia. The caterpillars are tawny above with a dorsal row of elliptical blue spots, on each side of which are two orange spots on each segment, and pale diffused orange lines and spots along the sides. They live in rather small compact nests and infest alder, apple, hawthorn, and wild and cultivated cherry, currant, and rose.

BOMBYCIDÆ. Silk Moths.

The Chinese or mulberry silkworm, *Bombyx mori* Linn., is by far the most important commercial member of the insect world, as it is the basis of large industries not only in Asiatic and European countries where the worms are reared and the raw silk produced, but also in America where much of the manufacturing of silk products occurs. Many vain efforts have been made to produce silk in California, but there is now one large company which hopes to succeed by adapting modern methods on a large scale to offset the cheap labor of foreign countries. The silkworm is native to Asia and has been domesticated for so many years that it cannot exist without the care of the human race. By careful selection, many races have been developed to meet the various needs of climate, rapidity of reproduction, and the color, quantity, and quality of the silk to be produced. The adult moths have a wing expanse of 40–45 mm., are robust, and creamy white with several faint lines across the fore wings. The small subspherical eggs are first yellowish white and become darker as the embryo develops; each female lays about 300. The caterpillars are rough, naked, whitish, and attain a length of 45–55 mm. and have a short anal horn. They feed on

white and black mulberry leaves which are picked for them each day. They also eat osage orange and even lettuce. Maturity is reached in 45 days and pupation occurs in a thick oval white or yellow silken cocoon. The adults emerge in 12–16 days. There are races of from one to six broods a year. For commercial purposes the pupæ are killed in the cocoons by heat or hot water and the raw silk reeled for subsequent use. The larvæ are subject to a severe hereditary disease known as pebrine which is caused by a myxosporidian parasite, *Nosema bombycis* Nägeli,[1] and is transmitted from the moths through the eggs. It is possible to eliminate this disease by a microscopic examination of the blood of the females and the use of eggs only from those free from contagion. The caterpillars are also subject to parasitism by certain tachina flies which oviposit on the mulberry leaves and thus gain entrance to the body by means of the alimentary tract. Silkworms are readily reared in confinement by first procuring the seed and then giving the developing larvæ fresh food daily. They remain in small uncovered containers and do not roam about if unconfined as do the caterpillars of all of our common moths.

GEOMETRIDÆ.[2] Loopers, Measuring Worms, Cankerworms.

The fall cankerworm, *Alsophila pometaria* (Harris) (*Anisopteryx*) (Fig. 576), is wingless in the adult female stage and winged in the male. They are both gray, the latter with pale bands across the fore wings. The eggs are shaped like small flower pots, being smaller at the bottom and with darker bands at the top. They are glued to the twigs side by side in regular clusters of from 50 to 200, are somewhat covered with hairs from the body of the parent, and are laid in the late fall or early winter. They hatch in the spring and the larvæ feed on the leaves and young fruit, often doing serious damage to apple, apricot, cherry, plum, prune, and other fruit trees. They also feed on basswood, birch, elm, geranium, maple, oak, and so forth. When mature, they average 25 mm. in length, are dark olive green with bright yellow side stripes and with three pairs of prolegs, the front pair more or less aborted. They move in the characteristic looping manner and also drop from the trees on a silken thread. Pupation occurs in the soil in the fall and the adults issue from October to December. The females climb up the trunks of the trees and lay the eggs on the limbs and smaller branches. There is but a single brood annually. The species is distributed throughout much of the United States and is recorded in Colorado, New Mexico, and California in the west. Bands of fly screen placed in the form of an inverted funnel around the bases of the trees and tacked or tied at the top effectively trap the females and prevent their climbing up the trees, if applied before the females issue in October. A

[1] R. Kudo, "On the Structure and Life History of *Nosema bombycis* Nägeli." *Bul. Imperial Sericultural Exp. Sta.* Tokyo, Japan. 1, No. 1, 1916.

[2] A. S. Packard, "Mon. of Geometrid Moths or *Phalænidæ* of U. S." F. V. Hayden's *Rept.* U. S. Geol. Surv. of Terr. 10, 1876.

Geo. D. Hulst, "Classification of *Geometrina* of N. A." *Trans. Am. Ent. Soc.*, 23, p. 245, 1896.

R. F. Pearsall, "List of *Geometridæ* Collected in Utah, Arizona and Texas." Mus. Brooklyn Inst. Arts and Sci. *Sci. Bul.*, June, 1906.

J. H. Comstock includes the families, *Geometridæ* and *Manidiidæ* and six subfamilies in the superfamily *Geometroidea*.

spray composed of 3 pounds of powdered arsenate of lead to 100 gallons of water or of 1 part of 40 per cent nicotine sulfate to 1,000 parts of water readily kills the caterpillars on the trees. Blackbirds often completely destroy an infestation of cankerworms in an orchard.

The spring cankerworm, *Paleacrita vernata* (Peck),[1] is very similar in general aspects to the preceding species in the adult and larval forms, but the latter lacks the small aborted pair of prolegs, having two rather than three pairs. The eggs also are oval and are laid singly or in irregular masses in the crevices or under the bark scales on the limbs and trunks of the trees

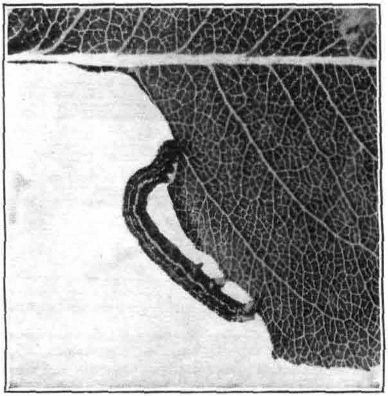


FIG. 576.—The larva of the fall cankerworm, *Alsophila pometaria* (Harris). Side view, showing the three pairs of prolegs at the rear end.

in the spring of the year. The cankerworms feed on the leaves and fruit and pupate in the soil where the winter is passed. The adults issue in the spring, mate, and the females lay their eggs in March, April, and May. Larvæ have been taken in Berkeley, California, as late as November 8th, indicating either more than one brood or a very irregular one. The species occurs in many parts of North America and is recorded in New Mexico, Utah, California, and other Western States. Control measures are the same as for the fall cankerworm.

Bruce's measuring worm, *Rachela bruceata* (Hulst), has been recorded as injuring the fruit of apple trees in British Columbia. The caterpillars are about 20 mm. long, pale green with yellowish side stripes, and with only two pairs of prolegs. The adults resemble those of the two preceding species. The winter is spent as pupæ in the soil and the adult females ascend the trees to lay eggs in the spring. Maple is a common native host in the Eastern States.

[1] A. L. Quaintance, Bul. 68, pt. 2, Bur. Ent. U. S. Dept. Agr., 1907.

The western gooseberry spanworm, *Itame flavicaria* (Packard),[1] **the western currant spanworm,** *Itame quadrilinearia* (Packard),[1] and **the currant spanworm,** *Itame ribearia*

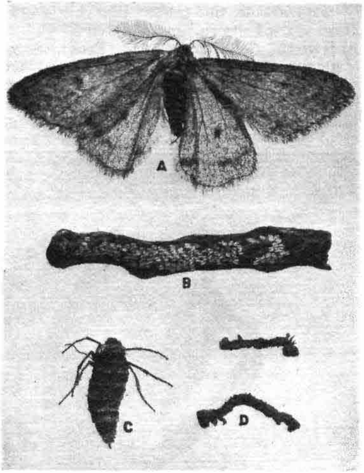


FIG. 577.—The walnut spanworm, *Coniodes plumogeraria* (Hulst). A, adult male; B, eggs; C, adult female; D, immature caterpillars.

(Fitch), are pests of currants and gooseberries in Colorado and various parts of the eastern United States. The caterpillars are 25 mm. long, whitish or pale, and covered with small black spots. The adults are winged and pale yellow with dark brown bands across the fore wings.

FIG. 578.—The eggs of the omnivorous looper, *Sabulodes caberata* Guenée.

The walnut spanworm, *Coniodes plumogeraria* (Hulst) (*Boarmia*) [2] (Fig. 577), is wingless in the female, while the male is winged and gray in color. The caterpillars attain a length of 20 mm. when mature, have three pairs of prolegs, and are pinkish gray varied with darker gray or purplish, or black and yellow. They normally feed on live oak, but also attack apple, prune, English walnut, and other fruit trees. In the Simi Valley of Southern California a large walnut orchard was completely defoliated in 1921. Pupation occurs two to four inches in the soil around the bases of the trees and the adults emerge in early spring. The females lay the oval, flattened, brassy or drab-colored eggs in masses on the limbs and small twigs in February and March. The species is known to occur in Colorado, California, Oregon,

[1] C. P. Gillette, Bul. 19, Colo. Agr. Exp. Sta., p. 23, 1892.
[2] D. W. Coquillett, Bur. Ent. U. S. Dept. Agr. Bul. 30, p. 26, 1893; Bul. 32, p. 22, 1894; Bul. 7 n. s., p. 64, 1897.

Washington, and British Columbia. There is but one brood a year. For control see the fall cankerworm.

The mottled umber moth, *Erannis defoliaria* Clerck, is apterous in the female and winged in the male. The former is yellowish green speckled with dark brown or black and often with two rows of dark spots on the dorsum; the latter is variable from dull yellow to brown, the front wings are dotted and with dark oblique bands, the hind wings pale, sprinkled with brown spots; the expanse is 45 mm. They appear in the late fall and early winter and lay the oval eggs on the buds and twigs, in bark crevices, and around pruning scars. The caterpillars hatch in April. They are chestnut brown above, yellow along the sides, and pale yellow to greenish beneath, and attain a length of 38 mm. when mature. Pupation occurs in the soil. The caterpillars feed on the leaves and developing fruit, and often seriously injure apple, apricot, beech, birch,

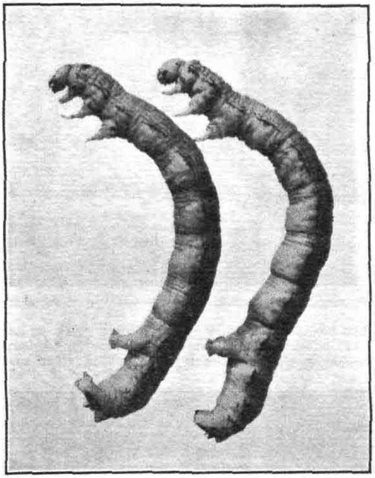


FIG. 579.—Mature caterpillars of the omnivorous looper, *Sabulodes caberata* Gn.

cherry, elm, filbert, lime, oak, peach, pear, and plum. It is a European species which has been introduced into Vancouver Island, British Columbia.

The oak looper, *Ellopia somniaria* Hulst, is periodically very destructive to oak trees in Oregon, Washington, and British Columbia. The winter is passed in the egg stage. The caterpillars are most abundant in August and the adults emerge in September and October.

The omnivorous looper, *Sabulodes caberata* Guenée (Figs. 578–581), is a beautiful, delicate fawn or terra-cotta colored moth above and nearly white beneath. Each wing has two irregular darker transverse median bands across the upper surface, and the wing expanse averages 50 mm. The moths appear in the spring and throughout the entire year in California, are commonly taken in the evenings and nights, and are found resting on various objects in the mornings. The small oval eggs are metallic green, amber, or pinkish brown, and are laid usually in small clusters on the leaves of the food plants during the late summer and fall. The caterpillars vary from yellow to pale green or pink, with yellow or green stripes on the sides and back and black markings

over the body. They have two well developed pairs of prolegs at the posterior end, and attain a length of 35–45 mm. They commonly spin a web in a leaf fold or between two or more leaves in which to rest during the day and into which they readily retreat

FIG. 580.—Pupæ and thin cocoon of the omnivorous looper, *Sabulodes caberata* Gn.

if disturbed. They are general feeders and have been taken on acacia, alder, aralia, avocado, box elder, buckeye, California laurel, California Christmas berry, cherry, chestnut, clematis, daisy, elm, English ivy, eucalyptus, geraniums, ginko, grevillea,

FIG. 581.—Adult of the omnivorous looper, *Sabulodes caberata* Gn., in natural resting pose.

groundsel, honeysuckle, lemon, lemon verbena, magnolia, maple, olive, orange, passion vine, pecan, pepper tree, rose, sumach, sycamore, tecoma, violet, black walnut, and willow. Pupation occurs within a thin cocoon under the web. The pupæ are almost white at first, but the developing wings soon turn to various shades of brown and the

eyes black. The winter is passed in the egg, young larval, and adult stages. There are several broods, but the last one to appear is usually the most injurious. The species occurs throughout California, but is not recorded in other Western States. It is seldom a serious pest, but is controlled by spraying with three pounds of arsenate of lead powder to 100 gallons of water, or with one part of 40 per cent nicotine sulfate to 600 parts of water. *Sabulodes forficaria* Guenée, has a grayish, flattened caterpillar which hides in the crevices of the bark and normally feeds on willow, but is sometimes found feeding on apple and English walnut in Southern California.

PSYCHIDÆ. Bagworms, Basketworms.

The tornillo bagworm, *Oiketicus townsendi* Cockerell (Fig. 582), is an umber brown moth with the body slightly darker than the wings, and an expanse of 35–37 mm. The

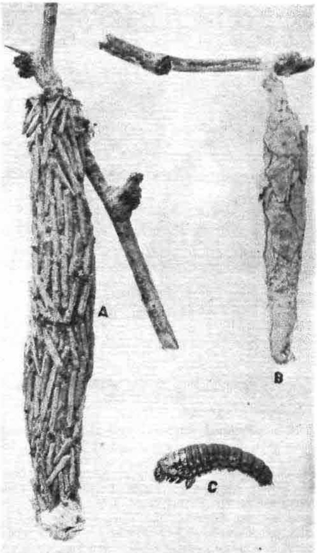


FIG. 582.—The tornillo bagworm, *Oiketicus townsendi* Ckll. A, bag made by larva feeding on mesquite in Mexico; B, bag made by larva feeding on sycamore in Arizona; C, larva or caterpillar removed from bag.

larvæ live in cases or bags 50–60 mm. long and made of silk, into which are incorporated leaves or small sticks which are few in number and held lengthwise. They commonly feed on the tornillo or porsopis and also attack apple, ash, pear, sycamore, willow, and locust. The species ranges from Mexico into New Mexico and Arizona. The larvæ of *O. davidsoni* Hy. Edw. build a similar but smaller case with more and larger sticks. They are only 40 mm. long, and occur in Southern California.

PYROMORPHIDÆ (*Zygænidæ*). Leaf Skeletonizers.

The western grape leaf skeletonizers, *Harrisiana brillians* B. & McD., *H. coracina* Clemens and *H. metallica* Stretch, appear as black and yellow larvæ late in the summer and feed on the leaves of wild and cultivated grapes. They occur in compact colonies and completely skeletonize the leaves. The adults are metallic black or green. The species range from Mexico into Texas, New Mexico, and Arizona.

PYRALIDÆ. Snout Moths.

The grape leaf folder, *Desmia funeralis* Hbn.,[1] is a common eastern insect known in the west in California and British Columbia. The adults have a wing expanse of 22–24 mm., and are very dark brown, with silvery iridescence, bordered with white. The fore wings have two oval white spots. The hind wings of the female have two white spots and those of the male, one. They emerge from the overwintering pupæ in April and May and deposit the minute, elliptical, reticulated eggs singly or in small groups

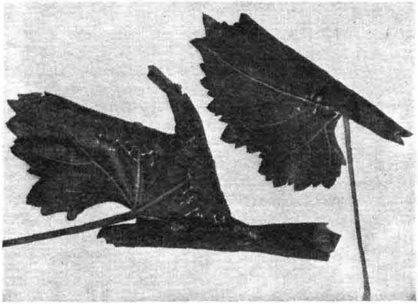


FIG. 583.—Grape leaves rolled and tied by the larvæ of the grape leaf folder, *Desmia funeralis* Hbn.

on the undersides of the leaves along the veins and also on the canes. The caterpillars feed on the leaves, the edges of which are rolled and tied (Fig. 583) in a characteristic manner to form a compact roll about the size of a lead pencil across one-third or one-half the surface in which they live. When fully developed, they are pale green with dark brown head and a brown spot on each side of the first two segments, and measure 25 mm. There are two broods, the caterpillars of the first appearing in June, are usually few in number, and seldom destructive. The second brood appears in July and is usually the more damaging to the vines. Pupation occurs within the leaf rolls, the chrysalids of the second brood remaining in the dead fallen leaves during the winter and the adults issuing from them in the spring. Wild and cultivated grapes are the preferred hosts but evening primroses, Virginia creeper, and red bud are also attacked. Artificial control is obtained by spraying with three pounds of powdered arsenate of lead to 100 gallons of water soon after the blossoms fall or when the caterpillars appear.

The imported cabbage webworm, *Hellula undalis* (Fabr.), is grayish, mottled brown in the adult stage, and the mature caterpillars are 13 mm. long, grayish yellow with purplish stripes along the body. The larvæ feed on the inner leaves, hearts, and stalks

[1] H. J. Quayle, Bul. 192, Cal., Agr. Exp. Sta., p. 129, 1907.
E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. p. 432, 1915.
J. F. Strauss, Bul. 419, Bur. Ent. U. S. Dept. Agr. 1916.

of cabbage, cauliflower, and kale plants, and also attack beets, collards, horseradish, radish, and weeds, which are usually covered with webbing. It is a cosmopolitan species, occurs throughout the country, and has been a pest in some sections of Southern California. Spraying with three pounds of powdered arsenate of lead to 100 gallons of water gives control.

The garden webworm, *Loxostege similalis* Guenée, is variable in the color of the adults, shading from yellow to buff with darker markings on the fore wings, and has an expanse of 20 mm. The caterpillars are dark yellow or pale green with numerous pale spots. They feed on weeds, grasses, grains, forage, and vegetable crops, and are common on, and often destructive to all. There are at least two generations. The species ranges from South America into much of the United States and has been observed in large numbers in New Mexico and Colorado. **The sugar beet webworm,** *Loxostege sticticalis* (Linn.),[1] is purplish brown with darker and paler wing bands and with an expanse of 25 mm. The adults appear in April, May, and June, and lay the pale yellow flat eggs singly or in rows, overlapping like fish scales. The caterpillars are pale or dark with three white longitudinal stripes and many black and white tubercles. The first brood appears in May and June, the second in July, and the third in August. The larvæ web the hosts, are general feeders, and are often very destructive to weeds, forage, and garden crops. They are particularly injurious to commercial plantings of sugar beets. The winter is passed in the larval stage in silk-lined burrows in the soil where pupation occurs in early spring. The species occurs in Europe and in New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, Arizona, and California in the west. **The alfalfa webworm,** *Loxostege commixtalis* (Walker), infests alfalfa in Colorado and occurs in Europe and various parts of North America.

The celery or greenhouse leaf-tier, *Phlyctænia ferrugalis* Hbn. (*P. rubigalis* Gn.), is pale reddish brown in the adult stage, the fore wings pale clay brown suffused with reddish brown and marked with black cross lines, the hind wings gray with darker margins, and the expanse 20 mm. The eggs are ovate, flattened, disc-like, translucent, and laid singly or in clusters of 3–15, overlapping like fish scales, on the undersides of the leaves or on the stems. They hatch in two to three weeks. The caterpillars are yellow to pale green with a green median dorsal line and two subdorsal white lines on each side, head pale with a few faint dark spots, the surface with a few long hairs, and are 20 mm. in length when full grown. They feed on the foliage which is webbed together often in large masses, and also mine the stems into the hearts of the plants, particularly of celery. When disturbed, the larvæ wriggle violently into their webs or to the ground. Pupation occurs within the webbed leaves. There are five or six generations. In the west the maximum development and injury in celery fields, as worked out by R. E. Campbell in Southern California, is from the middle of August to the first of December, and the minimum, from March to July. Commercial fields of celery are most seriously injured, but many other plants also serve as hosts, including anemone, beets, cabbage, carnations, cauliflower, chrysanthemum, cucumber, dahlia, daisies, geranium, heliotrope, kale, Kenilworth ivy, lantana, lettuce, lobelia, nasturtium, parsley, passion vine, peas, ragweed, roses, strawberry, thistles, tobacco,

[1] C. P. Gillette, Bul. 98, Colo. Agr. Exp. Sta. 1905.

violets, wandering Jew, and many other garden and greenhouse plants. In the regions of cold winters it is chiefly a greenhouse pest. The species occurs in Europe, Asia, and North America, and is recorded from Colorado, California, and British Columbia in the west. Control is obtained by carefully spraying with three pounds of powdered arsenate of lead to 100 gallons of water before the plants are half grown, to avoid injury to consumers. *Phlyctænia profundalis* Packard (Fig. 584) commonly infests hawksbeard, *Crepis* spp., along the Pacific Coast from California into British Columbia.

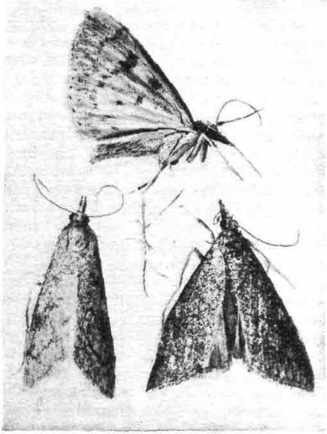


FIG. 584.—Adults of *Phlyctænia profundalis* Packard.

The adults are fawn or grayish with dark markings, and are often very abundant.

The meal snout moth, *Pyralis farinalis* Linn., is a cosmopolitan species which commonly infests cereals and cereal products. The adults have a wing expanse of 25 mm. the fore wings are light brown in the middle with white cross lines and dark brown at the base and tip, the hind wings are gray with two irregular whitish lines. The grayish larvæ live in a silken tube. Besides infesting cereals, they have been reported as attacking the roots of locoweed in Colorado.[1] **The clover hay worm,** *Hypsopygia costalis* (Fabr.), feeds on clover hay in stacks and reduces the quality, in Colorado. It also occurs in Europe and the Atlantic States. **The larger corn stalk borer,** *Diatræa zeacolella* Dyar, is straw-colored in the adult stage with brown veins and an expanse of 30–33 mm. The moths appear in March and April and lay eggs on the leaves. The caterpillars are 25 mm. long and white with pale yellow or brown spots. They bore the stalks and roots of corn, often doing considerable damage in Arizona and New Mexico. The larvæ hibernate in the stalks and roots and can be destroyed by burning stalks and the refuse, and deeply plowing under the stubble. **The small corn stalk borer,** *Diatræa lineolata*

[1] Bul. 64, pt. 5, Bur. Ent. U. S. Dept. Agr., p. 40, 1911.

Walker, also bores the stalks of corn and is frequently a pest of sorghums in Arizona, New Mexico, and Texas. *Herculia phæzalis* Dyar is a brown moth, the larvæ of which feed on cypress in Southern California. The cocoons are covered with frass.

The beemoth or waxworm, *Galleria mellonella* (Linn.)[1] (Figs. 585, 586), is a common inhabitant of beehives and often a serious pest in the apiary. The adults have a wing expanse of 28–30 mm., are gray or pale brown marked with black, and the tips of the wings are dull lead colored. The males are smaller than the females and are easily recognized by the scallop on the outer margins of the fore wings and the absence of palpi. The moths begin to emerge in April and May. The eggs are elliptical, pearly white, and about 0.05 mm. long. They are laid on or near the comb and hatch in ten or twelve days. The caterpillars, when first hatched, are white, and when fully developed vary from white to dirty yellow with brown or black head and prothoracic shield, or with the dorsum largely black. They burrow through the comb, feed on the wax, excrement, and exuviæ of the bees, and line their tunnels with silk. In time the entire contents of the hives may be destroyed or rendered a mass of refuse. Pupation occurs in thick, tough white bee-proof cocoons which are spun during the night around the edges of the frames, in cracks, on the walls of the hives or other convenient places near the infested comb. There are at least three broods. The eggs of the first brood are laid from the middle of April to the middle of May; of the second brood, from the middle of July to the middle of August; and of the third brood, from the last of September to the first of November. The length of the larval period varies from forty-five days for the first brood to thirty-five days for some of the second brood, and to several months for others of the second brood and those of the third brood which hibernate. The adults move freely at night, but have learned that they must remain perfectly motionless in the hives during the day in order to escape detection of the bees. The moth is an old-world species now generally distributed throughout the country wherever the honey bee occurs and is most serious in the warmer, drier regions and usually fails to persist where the winters are severe. *Semiotellus clisiocampæ* (Fitch) is reported by A. B. Gahan[2]

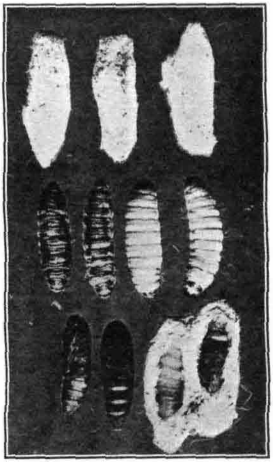


Fig. 585.—The beemoth or waxworm, *Galleria mellonella* (Linn.). Larvæ, cocoons, and chrysalids removed from beehive.

[1] F. B. Paddock, *The Beemoth or Waxworm.* Bul. 231, Texas Agr. Exp. Sta. 1918.
[2] *Ann. Ent. Soc. Am.*, 11, p. 175, 1918.

as parasitic on the larvæ after the cocoon is spun and sometimes on the pupæ. Strong colonies of bees are the most important natural enemies of the beemoth. Cleanliness is a most important factor in artificial control. All refuse should be eliminated about the hives. Infested hives should be thoroughly fumigated with carbon disulfid at the rate of two pounds to 100 cubic feet of air space, during the heat of the day when the gas is most effective or with paradichlorobenzene.

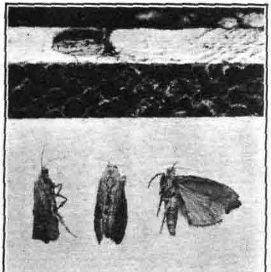


FIG. 586.—The beemoth or waxworm, *Galleria mellonella* (Linn.). Adult resting on frame in hive near a group of cocoons and empty brood cells at the top.

The Arizona navel orange worm, *Myelois venipars* Dyar,[1] is commonly associated with the black end rot of navel oranges in Arizona, and also occurs along the west coast of Mexico. The adults have a wing expanse of 16–19 mm., and are pale grayish marbled with brown and black. The eggs are ovate, flattened, white becoming pink or red with the development of the embryo, and with pale reticulations on the surface. They are usually laid in the navel end of injured oranges and are most abundant in September. The caterpillars are lemon yellow or dark gray with dark head and prothoracic and anal plates, with few body hairs, and attain a length of 17–20 mm. They occur throughout the year and feed on the tissues around the injured areas of the fruit. Injured navel oranges are preferred, but the larvæ also infest injured seedlings, Valencia and other oranges, and occasionally attack sound oranges and injured lemons. Pupation occurs within the fruit in a cocoon. The species caused considerable anxiety when found in 1920, but appears to be the same insect reported by T. D. A. Cockerell as early as 1899,[2] so has made little headway as an orchard pest since that time. An important undetermined egg parasite is reported by P. A. Glick.

The Zimmerman pine moth, *Pinipestis zimmermani* (Grote),[3] has a wing expanse of 30–35 mm. and varies from light to reddish gray with zigzag lines on the fore wings. The moths appear from May to September and are most numerous in July. The mature caterpillars are 20 mm. long, white, yellowish, gray, reddish, or greenish depending upon the host, with darker spots at the bases of the scattering hairs and brown head. They infest the main stems at the insertion of the branches and honeycomb the cambium of the trunks, completely girdling the trees of the second growth, and producing pitch tubes and causing spike top in mature timber of yellow pine, lodgepole pine, white pine, and other pines, and Douglas fir. The moth also commonly breeds in knotty growths produced on the terminal branches of yellow pines by a related species, *Pinipestis cambiicola* Dyar. Pupation occurs within bark or pitch. The winter is passed in both the egg and larval stages. The species occurs in the Northern

[1] D. C. Mote, "A New Orange Pest in Arizona." *Mthly. Bul.*, Calif. State Dept. Agr., **11**, p. 628, 1922.
P. A. Glick, *Fourteenth Ann. Rept.* Arizona Com. Agr. & Hort., p. 78, 1922. (Complete.)
[2] Bul. 32, Ariz. Agr. Exp. Sta., p. 289, 1899.
[3] Josef Brunner, Bul. 295, Bur. Ent. U. S. Dept. Agr. 1915.

States and is recorded from Montana, Colorado, Idaho, and Oregon in the west, and undoubtedly inhabits other adjacent States. The Rocky Mountain hairy woodpecker is the most important natural enemy. Control measures consist in eliminating infested and otherwise injured trees.

Dasypyga alternosquamella Ragonot is an important enemy of mistletoe growing on pine and spruce in California and Arizona. The white or pinkish caterpillars usually resemble the color of the host, are 20–22 mm. long, and feed singly and externally on the host, often in great numbers. *Ambesa mirabella* Dyar (Fig. 587) is a gray moth with ochre hind wings and reddish larvæ which were taken in large numbers on prune trees at Hopland, California, on May 11, 1922.

The lesser corn stalk borer, *Elasmopalpus lignosella* (Zeller), commonly mines the stems of corn, sorghum, Johnson grass, and beans in New Mexico, Arizona, and Southern California and extends throughout the States east of the Rocky Mountains. The adults are brown with pale markings. The larvæ are 20 mm. long and blue-green with broken brown longitudinial stripes. The latter hibernate in the stalks, stubble, and refuse, and are destroyed by burning or deeply plowing under these objects.

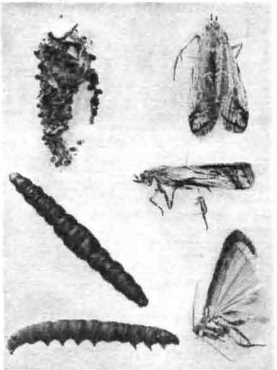


FIG. 587.—The prune pyralid, *Ambesa mirabella* Dyar. Cocoon, caterpillars, and adults.

The lupine and bean pod borer, *Etiella zinckenella* (Treitschke)[1] (Fig. 588), is a small gray moth with ochreous blotches and a broad white band and an ochreous band across the fore wings. The adults are very active and appear in the early spring. The caterpillars vary from white to pale green or reddish and attain a length of 25 mm. They commonly infest the green seed pods of lupines and beans and feed on the developing seeds. Bush lima beans are seriously injured in many sections, but small whites, pinks, red kidneys, peas, and the seeds of locust and wild vetches are also attacked. Pupation occurs in a thin cocoon within the pods, on the plant, or in the refuse beneath. There is apparently but a single brood. The insect occurs in Europe, Asia, Africa, South America, and throughout North America. The typical form occurs as far west as Colorado, and the form *schisticolor* Zeller is known in California, Oregon, Washington, and British Columbia. The elimination of lupines and all volunteer hosts and the rotation of crops are suggested means of control.

The currant and gooseberry fruit worm, *Zophodia franconiella* (Hulst) (*Z. bella* Hlst.), has pinkish larvæ 20 mm. long which eat holes in the berries and web the leaves of currants and gooseberries in Colorado. The moths are fuscous gray with white zigzag lines on the fore wings and an expanse of 28 mm. *Z. dilatifasciella* Ragonot is reported as feeding on the cottony cochineal scales on cactus in Mexico and Arizona.

[1] F. H. Chittenden, Bul. 82, pt. 3, Bur. Ent. U. S. Dept. Agr., p. 25, 1909.
J. A. Hyslop, Bul. 95, pt. 6, Bur. Ent. U. S. Dept. Agr., p. 82, 1912.
E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed. p. 433, 1915.

The walnut girdler, *Euzophera aglæella* Ragonot, mines the cambium and may completely girdle the native black walnut trees in Mexico, Arizona, and Utah. The adults are grayish marked with brown and black and with a wing expanse of 20 mm.

The American plum borer, *Euzophera semifuneralis* (Walker),[1] has a wing expanse of 18–25 mm., is ochre-fuscous, the fore wings pale gray with reddish brown and black markings. The mature caterpillars are 25 mm. long, dusky white, pinkish, or dull brownish green, somewhat resembling those of the codling moth. They enter the cracks, wounds and sunburned areas of injured and unhealthy trees, and make broad irregular burrows just under the bark at the forks, or under the surface of the ground, of apple, apricot, mountain ash, cherry, mulberry, peach, pear, persimmon, and plum, and may

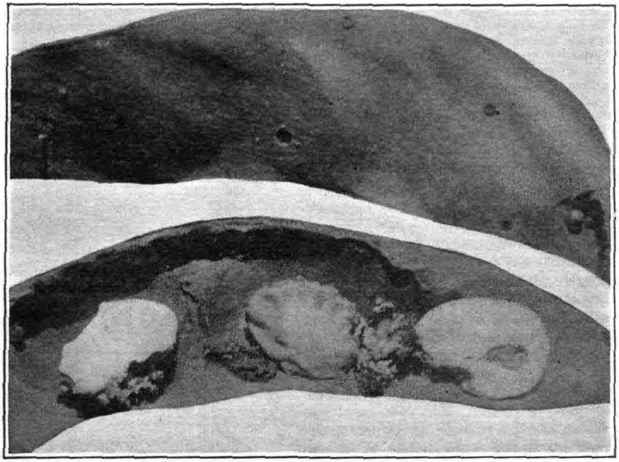


FIG. 588.—Work of the lupine and lima bean pod borer, *Etiella zinckenella* (Treit.), on pods and green bush lima beans.

hasten the death of the host. The species occurs in various parts of the United States and is known in Colorado, Utah, Arizona, California, and Washington in the west.

The dried fruit moth, *Vitula serratilineella* Ragonot, has been reared from dried fruits in California and from honeycomb in weak colonies of bees in British Columbia.[2] The larvæ are white or pinkish, the head, prothoracic shield, and anal plate, brown.

The coccid moth, *Lætilia coccidivora* Comstock, has a wing expanse of 10–18 mm. and is gray marked with brown and black. The eggs are white, oval and indented with five- or six-sided pits. The caterpillars are 8–12 mm. long, the upper surfaces olive green with bronze lustre, and the head, prothoracic shield, and legs black. They commonly feed on the cottony maple or vine scale in the Eastern and middle Western States, on the cottony cochineal scales on cactus in Texas, New Mexico, Arizona, and California, and on the black scale in California, although the species appears to be of little economic importance in the west.

[1] E. B. Blakeslee, Bul. 261, *Prof. Paper*, Bur. Ent. U. S. Dept. Agr. 1915.
[2] J. W. Cockle, *Proc. B. C. Ent. Soc.*, p. 32, 1920.

The sugar beet crown borer, *Hulstia undulatella* Clemens,[1] has a wing expanse of 12–16 mm., is gray marked with black scales and usually a red spot near the base of the fore wings. The hind wings are dusky. The caterpillars are 16–18 mm. in length, transparent, varying from pale green to yellow, the head pale brown and usually with a black dot on each side of the first segment. They attack sugar beets just below the bases of the leaves, eat the skin, and bore into the crown and down into the centre of the root. Extensive silken tubes in the soil extend from beet to beet in the rows. The species occurs throughout North America and is recorded in New Mexico, Arizona, Colorado, Utah, California, Oregon, Washington, and British Columbia in the west.

The Mediterranean flour moth, *Ephestia kuehniella* Zeller, has an expanse of 24–26 mm., is dark gray, the fore wings with transverse black zigzag markings, and the hind wings dusky white with darker margins. The adults appear throughout the year in flour mills, storehouses, stores, residences, or wherever cereals and cereal products are to be found, and deposit the small white oval eggs directly on or in the vicinity of the food. As many as 200 eggs are laid by a single female. They hatch in about a week. The larvæ are whitish with small black specks and sparse body hairs. They feed throughout the masses of food and live within silken tubes until ready to pupate, when a cocoon is spun. Infested flour and meal become felty and lumpy because of the webbing, and stop or clog machinery in mills. Cereal products are rendered unfit for use unless recleaned and even then they are not wholesome. The caterpillars have also been found feeding in chocolate candy, shelled walnuts, army biscuits, crackers, and so on. The length of the life cycle depends upon the temperature. Out of doors it may require two or three months and there may be but two or three broods a year, while in warm mills, stores, and warehouses, it may require but one to one and one-half months and there may be six or more broods annually. The moth is of European origin and has been carried with commerce throughout the world. Control is had by fumigation and heating.

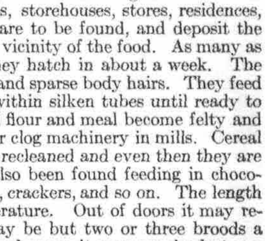


FIG. 589.—The Indian meal moth, *Plodia interpunctella* (Hbn.).

The chocolate moth, *Ephestia elutella* (Hbn.),[2] has a wing expanse of 20–24 mm., the fore wings are gray powdered with black scales and fuscous along the apical half; the hind wings are light fuscous. The pearly white eggs are oval and laid singly or in small masses on or in the food. The caterpillars are white or yellowish with brown head and prothoracic shield, and measure 20–30 mm. when mature. They are general feeders on cereals, cereal products, walnuts, dried fruits, chocolate, coffee, pepper, and so forth, and do considerable webbing. The distribution includes Europe, Asia, Pacific Islands, and the United States. The species does not appear to be established in the west, but is frequently taken in quarantine at the ports of entry. **The fig moth,** *Ephestia cautella* Walker,[3] is a common pest in dried figs in Asia Minor and Southern Europe and has been often introduced into the United States. The writer reared an adult from a larva taken in cotton seed in a box car in California, but the

[1] E. G. Titus, Bul. 54, Div. Ent. U. S. Dept. Agr., p. 34, 1905.
[2] F. Maskew, *Mthly. Bul.*, Cal. Hort. Com. 1, p. 366, 1912.
[3] F. H. Chittenden and E. G. Smyth, Bul. 104, Bur. Ent. U. S. Dept. Agr. 1911.

moth does not appear to be established in the west. *Ephestia rileyella* Ragonot infests yucca in Mexico, New Mexico, and Utah.

The Indian meal moth, *Plodia interpunctella* (Hbn.) (Figs. 589, 590), has a wing expanse of 20 mm., is pale gray with the apical two-thirds of the fore wings metallic coppery. Some forms are ochreous with the tips of the fore wings reddish brown. The eggs are pearly white, oval, very minute, and laid singly or in small groups. Each female may deposit from 300 to 400 eggs. The caterpillars vary in color and are white, yellow, pink, or greenish, with brown head and prothoracic shield. When mature they attain a length of 18–20 mm. They feed on cereals and cereal products, dried fruits, nuts, chocolate, and candies, and spin silken webs throughout and over these objects. Breeding continues during the entire year in favorable quarters, the life cycle requiring from four to five weeks. There are from four to seven broods annually. This insect is a very destructive pest and has caused large damage to dried fruits, shelled nuts, sugar, confectionaries, and cereal products in many parts of the west. It is cosmopolitan in distribution and has been carried with commerce everywhere. Heating to 125° to 130° F. or fumigating with hydrocyanic acid gas or with carbon disulfid give effective control.

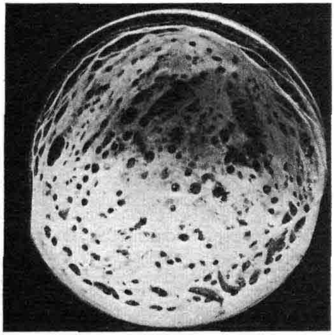


Fig. 590.—Caterpillars of the Indian meal moth, *Plodia interpunctella* (Hbn.), and compact web over a large glass containing infested shelled peanuts.

PTEROPHORIDÆ. Plume Moths.[1]

The artichoke plume moth, *Platyptilia carduidactyla* (Riley) (*Pterophorus*) (Figs. 591, 592), has a wing expanse of 20–27 mm. and is of various shades of buff and brown. The fore wings have a light spot on the front margin near the apices and are bifid for a short distance; the hind wings are a uniform gray and trifid. The mature caterpillars measure 15–20 mm., and are yellowish with shining black head, prothoracic shield, anal plate, and legs. They feed on the leaves and in the stems, but chiefly in the floral heads of the globe artichoke (Fig. 591) and are at times responsible for serious

[1] T. Walsingham, *Pterophoridæ of California and Oregon*, London, 1880.
C. H. Fernald, "*Pterophoridæ* of North America." *Mass. Agr. Rept. Spec. Bul.*, 1898.
F. Grinnell, "*Pterophoridæ* of Southern California." *Can. Ent.*, 40, p. 313, 1908.
E. Meyrick, "*Pterophoridæ.*" *Genera Insectorum, Fasc.*, 100, 1910. *Lep. Catalogus.*, Pars. 17, W. Junk, Berlin, 1913.
Wm. Barnes and A. W. Lindsay, "*Pterophoridæ.*" *Contrib. Nat. Hist. Lep. of N. A.*, 4, p. 281, 1921.

losses in the commercial fields in California. They overwinter and do most of the serious damage in March, April and May. Pupation occurs within the burrows, the naked pupæ being 10–13 mm. in length and of various shades of buff and brown. There are probably several broods, the summer forms of which feed on the stems and leaves of the artichokes and on various thistles. The larvæ are not gregarious in California as they are on Canada thistle in the Eastern States according to records. The species ranges along the Pacific Coast and throughout much of North America. A parasite, *Pyracmon* sp., has been reared from pupæ taken at Halfmoon Bay, California, by the writer and determined by R. A. Cushman. Control is

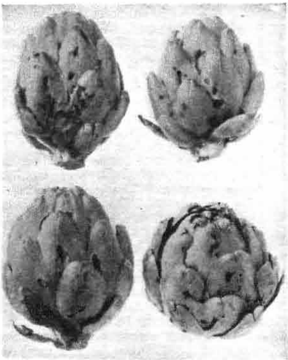


FIG. 591.—Globe artichokes showing the work of the larvæ of the artichoke plume moth, *Platyptilia carduidactyla* (Riley).

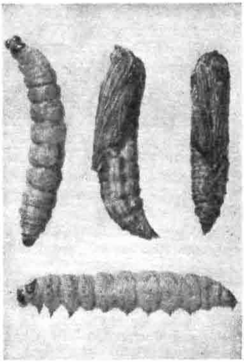


FIG. 592.—Larvæ and pupæ of the artichoke plume moth, *Platyptilia carduidactyla* (Riley).

best obtained by the careful destruction of all infested heads during the picking season, followed by the customary practice of cutting all the plants close to the ground in May and June.

Platyptilia acanthodactyla (Hübner) is dull brown with a wing expanse of 18–22 mm. The caterpillars vary from bright green to deep purple and feed on the leaves and buds of bartsia, euphrasia, geranium, hedge-nettle, mint, rest-harrow, and sage. The species is European and also occurs in California, having been reported as feeding on artichokes. *P. orthocarpi* Wlshm. feeds on *Orthocarpus* spp. in California, Oregon, Washington, British Columbia, Nevada, Utah, Montana, and Colorado. *P. punctidactyla* (Haworth) (*P. cosmodactyla* Hbn.) is a gray moth with white markings at the tips of the brownish front wings, and an expanse of 20–23 mm. The caterpillars are pale amber. They have been found feeding in the fruit bracts of the wild honeysuckle in Colorado and British Columbia, on Indian paint brush or on owl clover in Oregon, and in the floral heads of English marigold in California by the writer. In Europe the species is recorded on columbine and geranium. The western distribution also includes Oregon, Washington, and Alaska. *P. williamsi* Grinnell is a fawn colored moth with a wing expanse of 20–22 mm. The larvæ feed on the heads of the robust gum plant in Central California.

The morning glory plume moth, *Oidæmatophorus monodactylus* (Linn.) (*Alucita*, *Pterophorus*), is a tawny or dark brown moth with darker brown and white markings, and an expanse of 21–27 mm. The fore wings are bifid, cleft at about the middle, and the hind wings are trifid. The caterpillars are common on wild and cultivated morning glory, moonvine, and infest also sweet potato, atriplex, Joe-Pye weed or trumpet weed, calluna, and lambsquarters. The moth occurs in Europe, North Africa, Asia, and North America, and is reported common in New Mexico [1] and also in California and Oregon in the west. *O. grandis* (Fitch) (*Pterophorus baccharides* Grinnell) has an expanse of 30–36 mm., and is ochreous buff with darker marginal fringes. The larvæ are whitish or cream colored and infest the stems and larger branches of chapparal broom in the coastal region of Central California. Pupation occurs in the larval galleries. *O. grisescens* Wlshm. infests artemisia in Arizona, Colorado, California, Oregon, Washington, and British Columbia. **The sunflower plume moth,** *O. helianthi* (Wlshm.), has an expanse of 21–30 mm. and is brown with whitish markings. It infests the wild sunflower in Colorado, California, Oregon, Washington, and British Columbia. **The western plume moth,** *O. occidentalis* (Wlshm.), is creamy white to tawny, with an expanse of 26–29 mm. It also infests wild sunflower and is recorded from Arizona, Utah, Oregon, and British Columbia. **The ragweed plume moth,** *Adaina ambrosiæ* (Murtfeldt) (Fig. 593), has an expanse of 14–20 mm. The fore wings are bifid, cleft from about two-thirds, and the hind wings are trifid. The pale green larvæ feed on ragweed. The range is throughout the United States, and in Arizona and along the Pacific Coast in the west. **The wild grape plume moth,** *Pterophorus delawaricus* (Zeller), is golden brown with an expanse of 13–20 mm. The fore wings are bifid from the middle and the hind wings are trifid. The caterpillars are pale green with whitish head and subdorsal stripe and spots. They feed on wild grapes. The species occurs in the northern parts of the United States and in Canada. In the west it ranges from Southern California through Oregon and Washington into British Columbia. **The berry plume moth,** *Pterophorus tenuidactylus* (Fitch) (*Oxyptilus*), has an expanse of 13–17 mm., and is very dark brown with a bronze or copper lustre and white markings. The pale green caterpillars feed on the buds and leaves of wild and cultivated blackberry, loganberry, and thimbleberry in the Western States. The moth is known in Texas, California, and British Columbia.

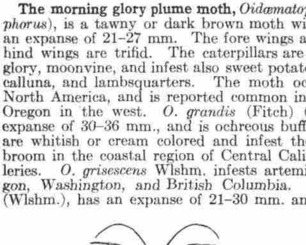


FIG. 593.—The ragweed plume moth, *Adaina ambrosiæ* (Murtfeldt). (After Woodworth.)

COSMOPTERYGIDÆ. Cosmopterygid Moths.

The false indigo gall moth, *Walshia amorphella* Clemens, is small, grayish yellow, spotted dark brown, and with a wing expanse of 12 mm. The caterpillars are white with the head and prothoracic shield dark brown, and when mature measure 12–18 mm. They form elongated, oval galls on the stems of false indigo and on the roots of locoweed in Colorado, and have been reared from tree lupine in California. In many cases the hosts are killed by the attacks. The species occurs also in Nevada and Utah in the west and throughout much of the United States.

The cascara pouch moth, *Cystiæcetes nimbosus* Braun, has a wing expanse of 10–12 mm., and is gray and white with several tufts on the wings. The caterpillars are pale grayish brown. They form pouches by tying together from above the halves of the leaves of cascara, on which they feed. The species occurs in many parts of California.

The pink scavenger worm, *Pyroderces rileyi* (Walsingham) (*Batrachedra*, *Batrachetra*), is a small golden mottled moth with a wing expanse of 11 mm. The pink caterpillars are 4–7 mm. long. They were first reared from rotten cotton bolls in the Southern Gulf States and were later observed in masses of mealybugs, upon which they were thought to feed, in Florida. In 1925 E. L. Garthwait sent the writer some heads of

[1] T. D. A. Cockerell, Bul. 35, N. M. Agr. Exp. Sta., p. 5, 1900.

milo maize which were badly infested with the larvæ of this moth with a report of considerable injury to this crop in the Imperial Valley, California. V. L. Wildermuth writes that this insect is a pest of all non-saccharine sorghums in New Mexico and Arizona and that it was particularly destructive in the Yuma Valley, Arizona in 1923. The larvæ feed on the grain in the heads in the fields and in storage. The invasions westward are undoubtedly due to a spreading from the Southern States.

GELECHIIDÆ. Gelechid Moths.[1]

The Angoumois grain moth, *Sitotroga cerealella* (Olivier), is a small, iridescent, pale yellow moth with a few darker markings on the fore wings and has an expanse of 20–25 mm. In storage the moths appear throughout the year, but in the fields they are most abundant in the fall just before the grain begins to ripen. They lay the small oval-elongate pinkish eggs in the outside of the kernels or in the heads of standing grain in late summer or fall, and the minute larvæ at once make their way into the kernels where they feed on the interior. In small grain like wheat and barley, usually only one individual occupies a kernel, but in corn there may be many. The work is rapid and often great losses are sustained in the fields or in storage. Pupation occurs within the infested kernels, the adults emerging through a small round hole. The life cycle requires about forty days and there are many overlapping broods in storage. Among the known foods are barley, beans, Japanese buckwheat, corn, cowpeas, sorghums, Sudan grass, and wheat, of which barley, corn, sorghum, and wheat are most susceptible. The species is cosmopolitan in distribution, having been carried in cereals by commerce, and occurs throughout this country. It was introduced into North America prior to 1743 and was the first insect discussed in an American scientific publication. The earliest possible harvesting of standing grain to prevent field infestation, and the fumigation of infested stored cereals, as recommended for the granary weevil, afford control.

The strawberry crown miner, *Aristotelia fragariæ* Busck,[2] has a wing expanse of 12 mm., is dark fuscous with yellowish and indistinct black scales on the fore wings, yellow anal tuft, and black legs with yellow rings. The larvæ are 10–14 mm. long, reddish with dark head, and much resemble those of the peach twig borer. They mine beneath the epidermis of the crowns or in the buds, leaves, and stems of the cultivated strawberry in Oregon and British Columbia. *Telphusa agrifolia* Braun occurs on live oak in Central California. *Gnorimoschema baccharisella* Busck has been reared from large oval galls from 10–25 mm. long, on the stems of chapparal broom at Berkeley, California.

The lodgepole pine needle miner, *Recurvaria milleri* Busck,[3] is a small white moth with black specks on the wings and an expanse of 12–15 mm. It begins to appear in July and is often present in countless numbers until the middle of August. The minute oblong-oval eggs are transparent and rugose, and are laid usually at the bases of the needles of the current year's growth. They hatch in about two weeks and the young larvæ at once begin to mine the needles. The first winter is passed as a small immature larva within the needles mined, and during the following summer usually two other new needles are destroyed, making three thus mined, covering a period of 23 months. Mature larvæ are 8 mm. long and vary from pale yellow to orange with a reddish dorsal line, and have a dark brown or black head, prothoracic shield, and anal plate. Pupa-

[1] August Busck, "Rev. of American *Gelechiidæ*." *Proc. U. S. Nat. Mus.*, 25, p. 767, 1903. "*Gelechiidæ* from British Columbia." *Proc. U. S. Nat. Mus.*, 27, p. 775, 1904.

[2] H. F. Wilson, *First Bien. Crop. Pest and Hort. Rept.* 1911–1912, Ore. Agr. Exp. Sta., p. 132, 1913.

[3] J. E. Patterson, "Life History of the Lodgepole Pine Needle-miner in the Yosemite National Park, California." *Jour. Agr. Research*, 21, p. 127, 1921.

tion occurs in early June of the second year within the last needle and the adults emerge in July and August, two years after the eggs are laid. During the second year the larvæ migrate twice and each attacks two needles which accounts for the more apparent injury every alternate year. The insect has defoliated large areas of lodgepole pine in the Yosemite National Park, California, and has thus made the trees susceptible to the attacks of barkbeetles which have killed many of them thus weakened. **The pine leaf miner,** *Recurvaria pinella* Busck,[1] attacks the needles of yellow pine in Colorado in a similar manner to the preceding species. **The spruce leaf miner,** *R. piceælla* Kearfott, mines the needles of various spruces in Colorado.

The potato tuber moth, *Phthorimæa operculella* (Zeller)[2] (Figs. 594, 595), is a small gray moth with silvery body and minute dark specks on the fore wings. The adults are nocturnal and appear throughout the year in storage and during the spring, summer, and fall in the fields. They deposit the small oval pearly white eggs on the leaves and stems of the plants, or on exposed tubers in the fields, and directly on the tubers in storage. Each female may lay from 150 to 300 eggs which hatch in a few days in the fields during the warm weather. The larvæ mine the leaves, stems, and tubers of potatoes in the fields and continue their work on the tubers in storage as long as anything suitable for food remains. They also mine the tops and fruits of tomatoes and many other plants. The caterpillars are white, yellow, pinkish, or greenish, with the head and prothoracic shield dark brown, and when mature measure 9–12 mm. Pupation occurs in a white silken cocoon in any secluded place, on the host, in the soil, sacks, or the storage bins. The length of the life cycle varies from one and a half months in midsummer to three months in winter. There are from four to six overlapping generations annually in the normal breeding places. The potato is most seriously injured, but tomatoes and tobacco have also been considerably damaged in some parts. Other hosts are bittersweet, cat tail, eggplant, false heath, ground cherry, henbane, horse nettle, hound's tongue, Jimpson weed, matrimony vine, mullein, nightshade, red pepper, toad flax, and many other solanaceous plants. The species has been widely distributed with potatoes and occurs in Australia, Tasmania, New Zea-

FIG. 594.—Potato showing the discolored and sunken skin over the burrows of the larvæ of the potato tuber moth, *Phthorimæa operculella* (Zeller).

[1] C. P. Gillette, *Thirteenth Ann. Rept. State Ent. Colo. Circ.*, 36, Colol. Agr. Exp. Sta., p. 26, 1922.

[2] W. T. Clarke, *The Potato-Worm in California*. Bul. 135, Cal. Agr. Exp. Sta., 1901.
E. O. Essig, "The Potato Tuber Moth." *Mthly. Bul.*, Cal. State Com. Hort., 1, p. 203, 1912.
F. H. Chittenden, "The Potato-tuber Moth." *Farmers' Bul.* 557, U. S. Dept. Agr. 1913.
J. E. Graf, "The Potato Tuber Moth." Bul. 427, Bur. Ent. *Prof. Paper*, U. S. Dept. Agr. 1917.

land, Hawaii, Southern Europe, Northern Africa, Canary Islands, Azores, India, and in the southern and southwestern parts of the United States. In the west it is most serious in the warm dry areas of Texas and California. Apparently it cannot exist outside in localities which have severe winters.

Artificial control consists in avoiding adobe soils, planting clean seed, planting deep, keeping potatoes well hilled, harvesting as early as possible,

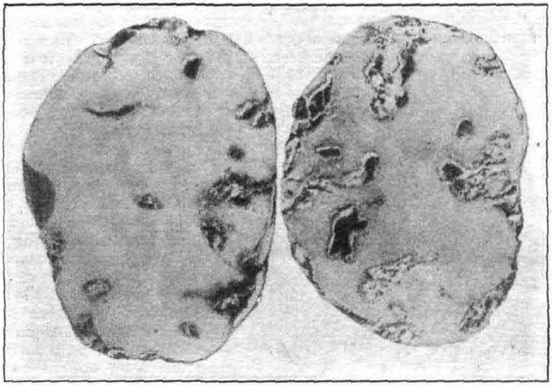


FIG. 595.—Cross section of a potato to show the burrows of the larvæ of the potato tuber moth, *Phthorimæa operculella* (Zeller).

leaving no potatoes exposed in the field overnight, not covering the tops of sacks with potato tops, storing in clean warehouses, fumigating infested potatoes with carbon disulfid using two pounds to 1,000 cubic feet of air space in a tight compartment or in a vacuum fumigatory to kill the worms and eggs, or placing in cold storage maintaining a temperature of 37° to 40° F. to prevent further development.

The eggplant leaf miner, *Phthorimæa glochinella* (Zeller),[1] is very similar to the preceding species, but the head and thorax of the adult are somewhat paler. The larvæ are first whitish, becoming brownish, greenish, or dark blue in color. When mature they measure 8 mm. They mine the edges of the leaves of eggplant, horse nettle, and tomato. The range includes Mexico, the Southern States, and Texas, New Mexico, Colorado, and California. Injury to tomatoes has been reported from California and Sinaloa, Mexico. T. H. Jones reports six hymenopterous parasites in Louisiana.

Phthorimæa striatella (Murtfeldt) has been reared from *Solanum* sp., in Southern California.

The huisache moth, *Polyhymno acaciella* Busck, is a small white, brown, and gray moth, the almost black caterpillars of which web together and feed on the leaves of huisache, *Acacia farnesiana* Willd., growing along the streets of San Diego, California.

[1] T. H. Jones, *Jour. Agr. Research*, 26, p. 567, 1923.

The western strawberry leaf roller, *Anacampsis fragariella* Busck, is a small pale brown moth with a darker brown transverse band across the front wings just beyond the middle, and a wing expanse of 15 mm. The small pinkish larvæ roll and devour the leaves of cultivated strawberries. A serious attack occurred at Hopland, California, in June, 1922.

The peach twig borer, *Anarsia lineatella* Zeller [1] (Figs. 596, 597), is steel gray with white and dark scales and has a wing expanse of 15–18 mm. The adults are nocturnal and are found resting on the undersides of the large limbs and in the crevices of the bark during the day. They appear in the spring, early summer, and fall, and lay the eggs on the twigs and fruit in the summer, and on the young branches in the autumn. The winter is passed in a very small larval condition in tiny cells or hibernaculæ (Fig. 596) just beneath the bark. In making these cells, the larvæ cast out the frass in the form of small piles or chimneys which readily serve to discover the silk-lined places of concealment, usually located in the crotches of two-year-old wood. When the buds begin to open in the spring, the larvæ leave the winter quarters, enter the tips of the developing twigs and burrow down the tender shoots killing them back three or four inches, or entirely (Fig. 597). Each larva can thus kill from one to several twigs and do great damage to nursery stock and young trees. Development is rapid so that the larvæ are fully grown by May when pupation occurs often behind a rude cross web over a wound or crack, without the spinning of a cocoon. Mature larvæ are very pinkish, dark red, brownish, or almost black, and 12–15 mm. long. The chrysalis is dark brown and 10–12 mm. long. The moths emerge in June and deposit the small pearly white, reticulated eggs on the fruit and twigs. The larvæ resulting from this brood largely infest the fruit of peaches and apricots as well as the developing nuts of almonds. A third brood of worms follows in the fall. Late peaches are most seriously injured by this last brood, as high as 80 per cent of the

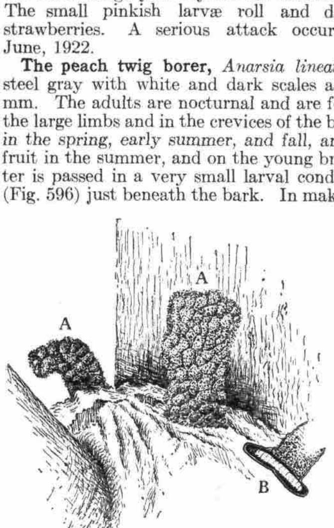


FIG. 596.—The peach twig borer, *Anarsia lineatella* Zeller. A, chimneys of the hibernaculæ in the crotch of a peach tree; B, cross section of a hibernacula showing hibernating caterpillar within.

[1] C. L. Marlatt, *The Peach Twig Borer*. Bul. 10 n. s., Div. Ent. U. S. Dept. Agr. 1898.
W. T. Clarke, *The Peach Worm*. Bul. 144; Cal. Agr. Exp. Sta. 1902.
H. F. Wilson, *Second Bien. Crop Pest and Hort. Rept.*, 1913–14, Ore. Agr. Exp. Sta., p. 113, 1915.
W. P. Duruz, *The Peach Twig Borer*, Bul. 355, Cal. Agr. Exp. Sta. 1923.

crop having been destroyed where control measures were not practiced. The moths from the third brood emerge in the fall and lay eggs which hatch into larvæ which go directly into hibernation. It appears that some larvæ from the first and second broods also go directly into hibernation which has been very confusing in determining the three broods. It is probable that in the northern limits but one or two broods occur. In Italy only two broods are recorded. Among the hosts are peach, nectarine, apricot, almond, cherry, prune, plum, apples, given in order of susceptibility. The species is European in origin and has been distributed throughout all peach-growing countries of the world on dormant nursery stock. It occurs throughout North America and in all Western States where peaches are commercially grown. A number of parasites are listed in Italy.[1] Artificial control for this insect was first worked out in California and published by W. T. Clarke in 1902 and consisted in the application of lime-sulfur solution which in the strength of 1-10 is still the standard remedy for the emerging larvæ if applied when the buds begin to swell in the spring. W. P. Duruz has found that ¾ pint of 40 per cent nicotine sulfate to 100 gallons of water, with three pounds of soap as a spreader, is preferable as a spring application on apricot trees which are often injured by the lime-sulfur. The above nicotine spray or three pounds of powdered arsenate of lead and ¾ pound of casein spreader to 100 gallons of water gives protection against the summer and fall attacks of the worms, if applied when the second and third brood worms begin to infest the fruit. The destruction of infested fruit and careful spraying of yard trees are necessary to secure the best results.

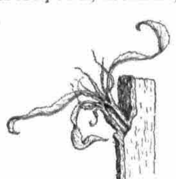


Fig. 597.—Cross section of young peach shoot killed by the peach twig borer, *Anarsia lineatella* Zeller, showing burrow. (After Clarke.)

The Arizona wild cotton moth, *Dichomeris deflecta* Busck, is white sprinkled with yellow, brown, and black scales, and has a wing expanse of 23 mm. The larvæ are white, the head and prothoracic shield dark reddish brown, and the anal plate black. They fold and tie the leaves together, and feed and pupate within the mass. Wild cotton is the native food plant in Arizona.

ŒCOPHORIDÆ.[2]

The brown apple moth, *Epicallima dimidiella* (Walsingham), is a small brown moth with several yellow and silver patches on the fore wings and an expanse of 16 mm. The caterpillars are 7.5 mm. long, dull gray with a subdorsal line on each side, shining brown head, dull gray prothoracic shield and anal plate, and almost white venter. The pupæ are pale gray, and 5 mm. long. This species is known in Colorado, Nevada, and California, and ranges north into British Columbia. Its native hosts are unknown. R. C. Treherne has taken the larvæ on apple in British Columbia.

The scavenger bulb moth, *Borkhausenia pseudospretella* Stainton, is a cosmopolitan feeder in decaying bulbs, sweet potatoes, and other vegetable products. It is recorded in California and ranges northward into British Columbia.

[1] R. Sarra, *Boll. Lab. Zoöl. Gen. Agrar. R. Scuola. Sup. Agr. Portici*, 10, pp. 51–65, 1915.

[2] A. Busck, "*Œcophoridæ* of British Columbia." *Proc. U. S. Nat. Mus.*, 27, p. 763, 1904. "Generic Rev. of American *Œcophoridæ*." *Proc. U. S. Nat. Mus.*, 35, p. 187, 1909.

BLASTOBASIDÆ.[1]

The icerya moth, *Holcocera iceryæella* (Riley),[2] has a wing expanse of 13–16 mm. and is ashy gray due to a mixture of light and dark scales on the thorax and fore wings. The hind wings are pale with yellow fringes and the abdomen silvery gray. The caterpillars are 6–10 mm. in length, dark reddish brown, dusky dorsally with narrow, pale dorsal and lateral lines, pale hair tubercles, and dark brown or black head and prothoracic shield. They are common in the egg masses and colonies of mealybugs and cottony cushion scale, under scales and among the colonies of black, brown apricot, peach, calico, Monterey pine, greedy and oyster shell scales upon the eggs, young, and adults of which they feed. Often considerable webbing is made about the feeding places by the caterpillars. This moth is thought to have been introduced from Australia but this has not been satisfactorily established. The species is quite common at Berkeley and San José, California. It has also been recently recorded from the southern part of the State as a pest to the fruit of oranges by A. J. Basinger. *Holcocera augusti* Heinrich is a golden yellow moth reared from the cones of Douglas fir which were infested with *Barbara colfaxiana* (Kearfott), in Oregon.

ÆGERIIDÆ (*Sesiidæ*).[3] Clear-Winged Moths.

The raspberry root borer or blackberry crown borer, *Bembecia marginata* (Harris),[4] is a large species, the males having an expanse of 20–27 mm., and the females 20–35 mm. The males have brown head with collar and palpi yellow; antennæ black, thorax dark brown with yellow marks and two spots on each side of the front; abdomen dark brown or black, a golden band on the posterior margin of each segment encircling the body; anal tuft black mixed with yellow; legs yellow, femora and tibiæ marked black on the outside; fore wings transparent with brown borders and brown discal spot; hind wings with narrow brown border and fringe; and veins brown. The females are more robust but similarly colored, excepting that the last abdominal segment is entirely yellow. The adults appear in late summer and fall and deposit the small, oval reddish brown eggs singly on the undersides of the leaves, each female laying as many as 135–150. The eggs hatch usually in September and the minute larvæ crawl down the stems and burrow into the canes or crowns, or live in the crevices of the bark of roots during the winter. In the spring they are scarcely longer than 10 mm. and begin active feeding on the roots and canes, which continues until winter when hibernation occurs in the nearly mature larval stage within the burrows in the canes and roots. In the second spring the larvæ continue to feed on the roots and crown and may burrow up the canes as

[1] Wm. G. Dietz, "Rev. of *Blastobasidæ* of N. A." *Trans. Am. Ent. Soc.*, 36, p. 1, 1901.
[2] E. O. Essig *Jour. Econ. Ent.*, 9, p. 369, 1916.
[3] Wm. Beutenmüller, "Mon. *Sesiidæ* N. A." *Mem. Am. Mus. Nat. Hist.*, N. Y. 1, pp. 217, 352, 1901.
A. Busck, "Notes on the Family *Ægeriidæ*, with a Synoptic Table of the N. A. Genera." *Proc. Ent. Soc. Wash.*, 11, p. 115, 1909.
Henry Edwards, "New Genera and Species of the Family *Ægeridæ*." *Papilio*, 1, pp. 179–208, 1881.
[4] W. H. Lawrence, *Ent. News*, 16, p. 117, 1905.
A. L. Lovett, *Third Crop Pest and Hort. Rept.* 1915–1920, Ore. Agr. Exp. Sta., p. 119, 1921.

much as four or five inches where pupation takes place in June, July, and August, the adults emerging in August and September. Thus two years

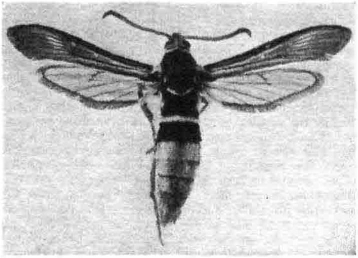


FIG. 598.—The hornet moth, *Alcathœ apiformis* (Clerck).

are required to complete a life cycle, and some adults emerge every year. The larvæ attack blackberries, loganberries, and black and red raspberries. Infested plants grow little, produce inferior fruit, and may die. The species occurs in various parts of North America and has been introduced with nursery stock into the berry-producing sections of the west, being now established in British Columbia, Washington, Oregon and California. It is also reported in New Mexico. Control consists in removing infested canes and roots and in burning them during pruning season. Paradichlorobenzene may also be used in the late fall at the rate of ½ ounce per bush.

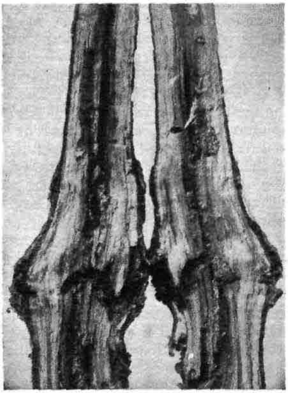


FIG. 599.—Work of the larvæ of the hornet moth, *Alcathœ apiformis* (Clerck), in the limb of the Balm of Gilead. A pupa is also shown within the burrow.

The hornet moth, *Alcathœ apiformis* (Clerck) (*Ægeria*) (Figs. 598, 599), has a wing expanse of 30–45 mm.; the thorax brown with a large yellow spot on the anterior of each side; the abdomen brown with a broad yellow band on the anterior portion of each segment except the last two which are all yellow; legs yellow, tinged brown; wings transparent with brown border. The moths resemble in size and color the European giant hornet, *Vespa crabro* Linn., but are very sluggish in habits. The caterpillars are robust, naked, white, with the head, shield, setæ, and rims of the spiracles brown. They make extensive burrows in the trunks and large limbs of poplars and willows often killing young trees. In the west, the Balm of Gilead

or balsam poplar seems to be most susceptible. Because of the attacks of this insect poplar trees are not satisfactory for shade and street plantings in California. Pupation occurs in the burrows. Two years are required for a complete generation. The species occurs in Europe, Siberia, and the United States, and ranges westward into Nevada and California.

The Pacific poplar moth, *Ægeria pacifica* (Hy. Edw.), also attacks poplars and willows in California, Nevada, Washington, and Montana, and is often mistaken in the larval form for the preceding species. The adults have the first two abdominal segments black, the second narrowly margined in front with yellow, the third segment yellow narrowly margined black posteriorly, and all the remaining segments wholly yellow.

The cottonwood crown borer, *Ægeria tibialis* (Harris), infests poplars and willows in various parts of North America and ranges west into Colorado, California, and British Columbia. The adults are similar to those of the preceding species but can be separated by the color of the abdominal segments, the first of which is black with posterior, narrow, yellow edge, the second black, the third black with posterior yellow margin, the fourth black, and the remaining brownish black with posterior yellow margins. The variety *dyari* Ckll. occurs in New Mexico.

The American clearwing, *Ægeria americana* Beut. (*Sesia*), has a wing expanse of 21–25 mm., is blue-black with an orange-red spot on each side beneath the thorax, and the fourth abdominal segment red. The larvæ burrow under the bark and into the heartwood of young limbs of alder in Nevada, Washington, and British Columbia. *A. albicornis* Hy. Edw. (*Sesia*) has an expanse of 15–22 mm., is black often with sparse white or yellow markings on the head and thorax and with the abdomen wholly black. The larvæ burrow the trunks and limbs of willows and frequently occur in the galls of *Saperda concolor* Lec. in the west, and in those of *Cryptorhynchus lapathi* (Linn.) in the east. The western distribution includes Colorado, Nevada, California, and Oregon.

The Pacific peach tree borer, *Ægeria opalescens* Hy. Edw.[1] (Fig. 600), is a serious pest to peach, apricot, and prune trees in the Western States. The adults resemble wasps in shape and coloration but are very sluggish in movement. The color is black or steel blue, the fringes of the wings and appendages, black. The legs have white tufts. The males have an expanse of 25–30 mm. and are entirely black with both pairs of wings transparent; the females have an expanse of 30–34 mm. and are metallic blue-black with opaque fore wings and transparent hind wings. They appear in late June, in July and August, and are usually found resting on the trunks and limbs of the host trees. When disturbed they have a very quick erratic flight. The small cinnamon brown eggs are oval, depressed dorsally and finely reticulated with paler lines. They are laid during July or August, singly or in masses up to fifty in number, on the surface or more often in the cracks of the bark of the trunks, and are difficult to discern excepting on the smooth gray bark of young trees. Each female lays from 200 to 450 eggs, which require from fifteen to thirty days for hatching. The young larvæ immediately seek shelter in cracks of the bark and gradually make their way down the trunk and enter directly through the soft damp bark or old burrows beneath the surface of the soil. The caterpillars are naked white or yellowish with brown heads and much wrinkled bodies, and attain a length of 25–40 mm. They usually work around the crown of the trees, just under the bark at or below the surface of the ground, though in extreme

[1] C. W. Woodworth, Bul. 143, Cal. Agr. Exp. Sta. 1902.
D. Moulton, Bul. 97, pt. 4, Bur. Ent. U. S. Dept. Agr. 1911.
E. O. Essig, *Inj. & Ben. Ins. Cal.*, 2d ed., p. 422, 1915.
F. H. Lathrop and A. B. Black, *Third Crop Pest and Hort. Rept.* 1915–1920. Ore. Agr. Exp. Sta., p. 59, 1921.
The writer is following August Busck in the use of *Ægeria* in preference to *Synanthedon* in this and other species.

cases the burrows may extend a considerable distance up the trunks. Quantities of sap, gum, and frass exude from the openings of the burrows and are evidences of the presence of the insect. The work after successive seasons may partially or entirely girdle the tree. Young trees are most susceptible and are frequently killed in a single year in the nursery or before they are six years old, in the orchard. Maturity is reached in May, June, and July, and pupation takes place in a frass-covered cocoon within the entrance of the burrow or just outside on the trunks, or in the soil. Adults emerge in twenty to thirty days and leave the pupal skins partially with-

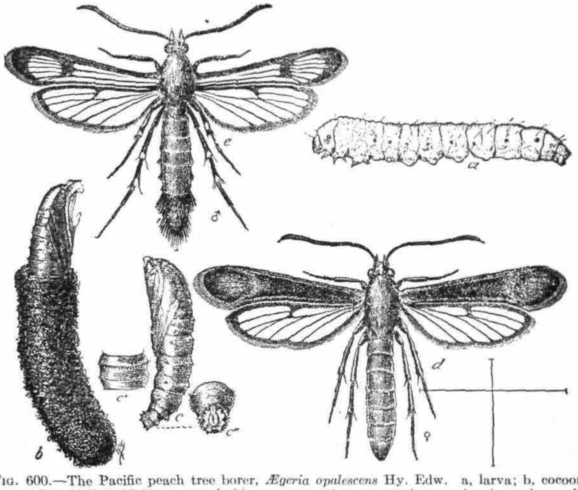


FIG. 600.—The Pacific peach tree borer, *Ægeria opalescens* Hy. Edw. a, larva; b, cocoon and partially withdrawn pupal skin; c, pupa; c', segment of pupa showing spines; c'', posterior end of pupa; d, adult female; e, adult male. (After Moulton, U. S. Dept. Agr.)

drawn from the cocoons. There is only one generation annually, but larvæ of all sizes are found in the burrows during the winter and early spring, indicating that the brood is very much drawn out or that some stragglers remain in the burrows two winters. Peach or other trees on peach rootstocks are preferred. Almond, apricot, cherry, western choke cherry, plums, prunes, and other members of the genus *Prunus* are also attacked. The Myrobalan plum rootstock used for apricots, plums, and prunes was thought for some time to be immune, but the writer found it to be very generally infested. Apricot trees on their own roots are most resistant to attacks and in many instances appear to be entirely immune. This species is strictly western and is known in California, Nevada, Oregon, Washington,

and British Columbia. Control measures are very simple since the discovery of the paradichlorobenzene treatment by E. B. Blakeslee [1] which has entirely replaced the digging out of the borers and the application of asphaltum.[2] The paradichlorobenzene is a crystalline material which is insoluble in water and volatilizes slowly at a temperature of 55° F. to 75° F., and more rapidly at higher temperatures. The vapor is more than five times heavier than air and more than twice as heavy as the vapor of carbon disulfid. It possesses a pungent odor which is practically nonpoisonous to humans. It is noncombustible also, so that it can be handled with perfect safety. From three-fourths to one ounce is a sufficient amount for an average size tree. First level the surface of the soil around the base of the tree, then sprinkle the crystals around in a continuous ring about two inches wide with the inner margin two to four inches from the bark of the tree. Cover about the base of the tree, using six to eight shovels of earth and pack well with a few strokes of the shovel. The soil prevents the upward passage of the vapor and confines it to the infested portions of the tree. The most favorable time for application is in the late summer and fall when the soil is warm and the moisture not excessive. During the past year more than five tons of this material has been used in the San Francisco Bay region on apricot and prune trees without a single case of injury even to one-year-old nursery stock. The small cost, ease and quickness of application, and the effectiveness of the material make it a great discovery not only for this borer, but also for many other soil-infesting insects.

The peach tree borer, *Ægeria exitiosa* Say [3] (Fig. 601), is the most serious enemy of the peach in many parts of the United States and is similar in habits to the above species. The adults have an expanse of 18–32 mm., and are deep metallic blue-black. The males have yellow marks on the thorax, a yellow band on the posterior margin of each abdominal segment, and the wings transparent with black margins; the females have the fourth abdominal segment orange-red above, the fifth segment sometimes sprinkled with red scales, and the fore wings entirely opaque. The life history, nature of the work, habits, and hosts are much like those of the preceding species, and control measures are the same. This species extends westward into Colorado, New Mexico, Arizona, Utah, Oregon, and British Columbia. A single infestation on a few peach trees in San Diego County, California, was completely eradicated by the destruction of the trees in 1914.[4]

The imported currrant borer, *Ægeria tipuliformis* (Linn.) (*Sesia*) (Fig. 602.), is a small wasp-like species with an expanse of 15–21 mm., black with transparent wings, with four yellow bands on the abdomen of the male and three on the female. The adults appear in May and June and the small light brown globular eggs are laid in the cracks of the bark at the axils of the leaves and buds of currant and gooseberry on canes less than one year old. From twenty to sixty eggs are laid by each female. Hatching follows quickly and the larvæ bore into and down the inner pith of the canes (Fig.

[1] Bul. 796, Bur. Ent. U. S. Dept. Agr., p. 4, 1919.
[2] Earl Morris, Bul. 228, Cal. Agr. Exp. Sta., p. 372, 1912.
[3] M. V. Slingerland, *Cornell Agr. Exp. Sta. Bul.* 176, 1889; Bul. 192, 1901.
C. L. Marlatt, *Circ.* 54, Div. Ent. U. S. Dept. Agr. 1903.
G. G. Becker, *Tech. Bul.* 150, Ark. Agr. Exp. Sta. 1918.
[4] E. O. Essig, *Inj. & Ben. Ins. Cal.* 2d ed., p. 421, 1915.

602) and often into the larger roots. Single canes or the entire plant are killed in this manner. The larvæ are white or yellowish with dark brown head and measure 12–20 mm. when mature. Winter is passed in the larval stage within the burrows where pupation occurs in April, May, and June. There is a single brood annually. The species is the most widely distributed member of the family and occurs in Europe, Asia, Australia, New Zealand, and throughout North America. In the west it is known in Colorado, Nevada, California, and British Columbia. European writers list box elder, sumach, and hazel in addition to

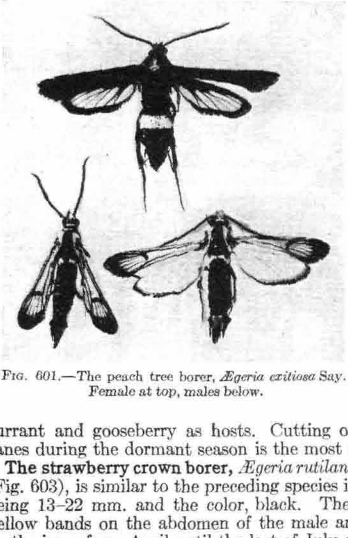


FIG. 601.—The peach tree borer, *Ægeria exitiosa* Say. Female at top, males below.

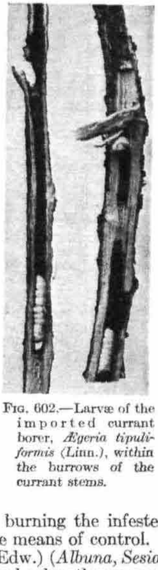


FIG. 602.—Larvæ of the imported currant borer, *Ægeria tipuliformis* (Linn.), within the burrows of the currant stems.

currant and gooseberry as hosts. Cutting out and burning the infested canes during the dormant season is the most effective means of control.

The strawberry crown borer, *Ægeria rutilans* (Hy. Edw.) (*Albuna, Sesia*) (Fig. 603), is similar to the preceding species in size and color, the expanse being 13–22 mm. and the color, black. There are two or, rarely, three yellow bands on the abdomen of the male and four on the female. The moths issue from April until the last of July and oviposit in crowns of the wild and cultivated strawberry plants. The caterpillars are pale yellow or whitish with brown head, and attain a length of 15 mm. They work chiefly in the crown of the strawberry which may be entirely hollowed out or girdled and their attacks usually result in the complete death of the infested plant (Fig. 603). They are also occasionally taken in the canes and roots of blackberries and raspberries and are apt to be confused with the larvæ of *Bembecia marginata* (Harris). This species occurs in many parts of northern North America, but is most common in the west where it is

known in Texas, Colorado, Utah, Idaho, Nevada, California, Oregon, Washington, and British Columbia. It is most serious as a pest in small home gardens and does not appear to be able to withstand the constant floodings by irrigation of the commercial plantings of strawberries in Cali-

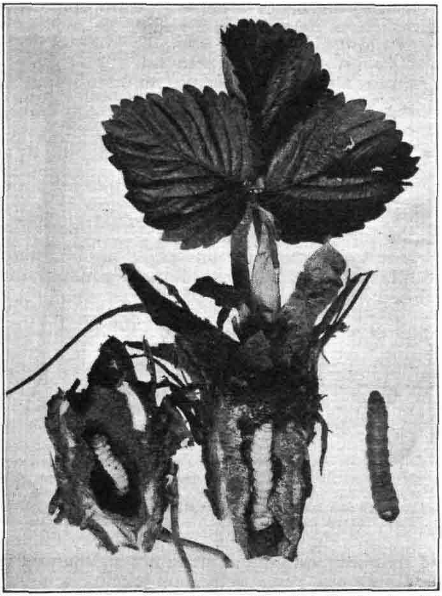


FIG. 603.—The strawberry crown borer, *Ægeria rutilans* (Hy. Edw.), and work in the crowns of strawberries.

fornia. The elimination of infested plants and the use of cloth or wire screens are recommended in small plantings where the water supply is inadequate for frequent floodings. The tachina fly, *Leskia gilensis* (Townsend), has been reared from pupæ in Oregon and also ranges south into New Mexico.

The wild cherry borer, *Ægeria græfi* (Hy. Edw.), infests the main roots of wild cherry in Colorado, Nevada, and Washington. The moth is black, the abdomen of the male banded with yellow, and the female entirely black with opaque wings. The variety *barnesi* Beut. has the fourth abdominal segment of the female orange, much like *A. exitiosa* Say.

The Douglas fir pitch moth, *Ægeria novaroënsis* Hy. Edw. (*Sesia*),[1] has an expanse of 30–40 mm., and is black with orange red spots on the thorax, all segments except the last banded with orange red. The eggs are oval and brown. The larvæ are transparent white with dark brown head, and attain a length of 25–40 mm. The adults emerge from May to August and oviposit on the trunks of the trees. The larvæ mine through the bark and sap and into the heartwood of the trunks of Douglas fir and western larch, entering through the perfectly healthy tissues or by means of wounds, and prefer trees from ten to fifty years old growing on the shady northern slopes. The presence of the burrow is usually indicated by a pitch tube about two inches in diameter on the bark. Four years are required to complete a generation, according to Brunner. The species occurs throughout the northern Rocky Mountain and Pacific Coast regions and is most destructive in the latter area. *A. brunneri* (Busck) (*Sesia*) is similar in coloration but has red transverse bands only on the second and fourth segments, with traces on the other abdominal segments. It is smaller with an expanse of 24–27 mm. It infests yellow pine and lodgepole pine in Montana and Idaho, and often follows the attacks of *Pinipestis zimmermani* Grote. *Ægeria decipiens* Hy. Edw. (*Sesia*) inhabits as an inquiline the woody twig galls of a cynipid on scrub white oak in Colorado.

The western sycamore borer, *Ægeria mellinipennis* (Bdv.) (*Sesia*), is much like a yellow jacket in appearance. It is black marked with bright yellow and with five very broad yellow bands on the abdomen of the male and four on the female. The margins of the transparent fore wings are reddish, golden yellow, or bronze. The larvæ are 15 mm. long and of the usual form and color. They have been reported as mining the solid wood of ceanothus or blue myrtle or blue blossom,[2] and oak in California. The writer found them very numerous under the bark of the main trunks of old trees of the western sycamore at Laguna Beach, California, in 1921. The larvæ were confining their attacks from the ground to a height of six feet and great quantities of reddish frass was clinging in the cracks and crevices of the bark and heaped on the ground about the bases of the trees. Adults were emerging and hovering about the trees on July 23rd, and were determined by A. Busck. The species occurs also in Colorado. **The red clearwing,** *A. polygoni* (Hy. Edw.), is a small species in which the fourth and last two abdominal segments are red. The dirty white larvæ mine the crowns of various knotweeds, *Polygonum* spp., in California. *A. prosopis* (Hy. Edw.) is a small species with an expanse of 14 mm. and has two white bands on the abdomen of the male. The larvæ inhabit galls on mesquite in Arizona. **The Sitka spruce borer,** *Parharmonia picea* Dyar, is shining black with transparent wings and a reddish patch on the venter of the third abdominal segment. The larvæ infest Sitka spruce in Washington. **The lilac borer,** *Podosesia syringæ* (Harris) (*Ægeria*), has an expanse of 25–36 mm. and is mostly black and chestnut brown with the forewings opaque. The larvæ mine the solid wood of lilac and ash trees in the Eastern States and range west into Colorado.

The sequoia pitch moth, *Vespamima sequoiæ* (Hy. Edw.),[3] resembles a yellow jacket, has a wing expanse of 24–30 mm., and is black with the last three segments of the abdomen in the female and the last four of the male bordered with bright yellow. The larvæ are dirty white and opaque. They infest the branches and bases of the trees and mine the cambium layer of knobcone pine, lodgepole pine, Monterey pine, yellow pine, Douglas fir, redwood, and other coniferous trees. Pitch tubes frequently form over the burrows. The range includes Montana, Washington, Oregon, and California. **The man root borer,** *Melittia gloriosa* Hy. Edw., is one of the most striking and beautiful moths in the west. The adults are large, robust, with a wing expanse of 40–58 mm. The head, thorax, and fore wings are gray or brownish, the hind wings, sides of the abdomen, and portions of the hind legs are reddish orange, the remainder of the abdomen is black and yellow, and portions of the hind legs, black. The front wings are opaque in both sexes, the hind wings opaque in the female and transparent in the male. The larvæ are reported to mine the roots of sumach and commonly infest the climbing stems and fleshy roots of big root or man root in Oregon, California, and Arizona. *M. grandis* (Strecker) differs from the preceding species in having a greenish tinge to the body and fore wings and the hind wings of the female transparent. It occurs in Arizona, New Mexico, Texas, and Mexico.

[1] J. Brunner, Bul. 255, *Prof. Paper*, Bur. Ent. U. S. Dept. Agr. 1915.
[2] F. X. Williams, *Ent. News*, 20, p. 58, 1909.
[3] J. Brunner, Bul. 111, *Prof. Paper*, Bur. Ent. U. S. Dept. Agr. 1914.

The locust clearwing, *Paranthrene robiniæ* (Hy. Edw.) (*Memythrus*), has an expanse of 26–36 mm., the fore wings opaque, ochreous yellow, and the abdomen yellow with the three basal segments black. The larvæ are very destructive borers to the common locust, white poplar, and downy poplar, used for ornamental plantings in Nevada, California, and Washington.

EUCOSMIDÆ or OLETHREUTIDÆ (*Epiplemidæ*).[1]

The lodgepole pine tip moth, *Rhyacionia montana* (Busck) (*Evetria*), destroys the terminal buds of the small branches of lodgepole pine in Montana. **The Monterey pine tip moth,** *R. pasadenana* (Kearfott) (*Evetria*), has an expanse of 14–17 mm. and is reddish and silvery gray. The larvæ infest the terminals of the branches of the Monterey pine and other pines along the coast of California. *R. frustrana* (Comst.) *bushnelli* (Busck) (*Evetria bushnelli* Busck) seriously infests the buds of yellow and ornamental pines in Nebraska, New Mexico, and Arizona. *Petrova metallica* (Busck) (*Evetria*) infests yellow and lodgepole pines in Montana and causes pitch tubes in the tips of the small branches. *P. luculentana* (Heinrich) (*Evetria*) similarly works on yellow pine in Colorado. *P. sabiniana* (Kearfott) (*Evetria*) is a striking orange yellow and white species which infests digger pine in California and forms pitch pockets in which the larvæ live. *P. monophylliana* (Kearfott) (*Evetria*) infests the branchlets of the single-leaf pine in California. *P. burkeana* (Kearfott) (*Evetria*) has been reared from Sitka and Engelmann spruces in Washington and Montana. The adults are whitish with gray markings and have a wing expanse of 26–28 mm. *P. picicolana* (Dyar) (*Eucosma*) infests white and alpine firs in Washington. *Barbara colfaxiana* (Kearfott) (*Evetria*) is whitish and fuscous, mottled gray and black with a wing expanse of 15–21 mm. The larvæ infest the cones of Douglas fir in California, Oregon, Washington, and British Columbia. The variety *siskiyouana* (Kearfott) (*Evetria*) is somewhat larger and infests the cones of white fir and red fir in California and Oregon. The variety *coloradensis* (Heinrich) infests Douglas fir and spruce in Colorado and the variety *taxifoliella* (Busck) attacks Douglas fir in Montana. *Barbara ulteriorana* (Heinrich) is believed to be a large aberrant form of the preceding species. It infests the cones of Douglas fir in Oregon.

The wild iris moth, *Olethreutes rubipunctana* (Kearfott) (*Argyroploce*), has an expanse of 17–22 mm. and is reddish brown, mottled black, brown, slate, and pale fawn. The caterpillars feed and pupate in the seed pods of various species of wild iris in Colorado, Nevada, California, Oregon, and Washington. The writer has taken the larvæ of a destructive noctuid moth from iris pods in Northern California. *Olethreutes consanguinana* (Wlshm.) feeds on apple in British Columbia and ranges south into California. *O. compestrana* Zeller is common on thimbleberry in British Columbia, Washington, Oregon, California, Nevada, Utah, Colorado and Arizona, and also occurs in the New England States. **The box elder twig borer,** *Proteoteras willingana* (Kearfott), is reported attacking the twigs of a large percentage of the box elder trees in Utah by W. W. Jones. **The Douglas fir cone moth,** *Zeiraphera diniana* (Guenée) (*Enarmonia pseudotsugana* Kearfott),[2] is a small fawn, fuscous, and gray moth with an expanse of 7 mm. The larvæ infest the cones of Douglas fir in Montana and British Columbia.

The bud moth, *Spilonota ocellana* (Denis and Schiffermüller) (*Tortrix, Tmetocera*), is an important orchard pest in Europe and the northern part of North America. The adults have an expanse of 12–16 mm., and are gray with a wide whitish band across each fore wing. They appear in June and July and the females lay the small, transparent, disc-like eggs singly or in clusters on the under surfaces of the leaves. Hatching follows in about a week and the caterpillars after feeding on the leaves hibernate in small inconspicuous cocoons on the bark of the trees. In the spring they feed in the leaf and blossom buds and often tie the leaves and blossoms

[1] W. D. Kearfott, "New N. A. *Tortricidæ*." *Trans. Am. Ent. Soc.*, 33, p. 1, 1907.
Carl Heinrich, *Rev. of N. A. Moths of Subfamily Eucosminæ of the Family Olethreutidæ*. Bul. 123, U. S. Nat. Mus. 1923.

[2] R. A. Cooley, Bul. 70, Mont. Agr. Exp. Sta., 1908.

together with silk. The mature caterpillars are 12 mm. long, reddish brown with shining black anal shield, and somewhat resemble the larvæ of *Anarsia lineatella* Zeller, but in the latter the anal shield is the color of the body. There is but a single brood. The hosts are apple, blackberry, cherry, hawthorn, laurel, oak, pear, plum, prune, and peach. The western distribution includes Montana, Idaho, Oregon, Washington, and British Columbia. Spraying with three pounds of powdered arsenate of lead to 100 gallons of water to kill the larvæ in the late fall or in the early spring gives control.

The strawberry leaf roller, *Ancylis comptana* (Fröhlich), has a wing expanse of 10–14 mm. and is rusty red with white markings. The larvæ are reddish brown or greenish and 20 mm. long when mature. They feed on the leaves of wild and cultivated strawberries, blackberries, and raspberries, and web the leaves together in rolls in which they live. The species is European in origin and now occurs in many parts of North America. Several varieties

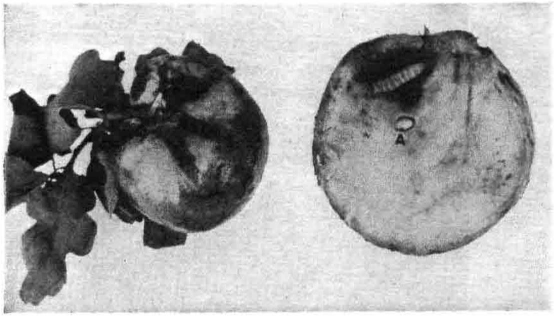


FIG. 604.—Larva of the Catalina cherry moth, *Melissopus latiferreanus* (Wlshm.), and work on the green oak apples or galls of the California gall fly, *Andricus californicus* (Bassett), on blue oak. A, larva of the gall fly.

are recognized by Heinrich, of which *cometana* (Wlshm.) is a dark western form occurring along the coast of northern California; *fragariæ* (Walsh and Riley) is the pale form known in Colorado and Idaho in the west and which ranges to the Atlantic.

The lesser apple worm, *Laspeyresia prunivora* (Wlshm.),[1] is a common apple pest east of the Rocky Mountains which occurs in British Columbia in the west. The adults have an expanse of 15–18 mm. and are pale rusty red with irregular gray, pale yellowish white, and bluish oblique lines on the fore wings. The small transparent disc-like eggs are laid on the upper surfaces of the leaves and on the green fruit. The larvæ are 8–10 mm.

[1] A. L. Quaintance, Bul. 68, pt. 5, p. 49, 1908.
S. W. Foster amd P. R. Jones, Bul. 80, pt. 3, p. 45, 1909.
E. P. Taylor, *Jour. Econ. Ent.*, 2, p. 237, 1909.

long when mature and are white or pinkish. They may be confused with those of the codling moth, but are smaller and have a peculiar comblike structure made of a parallel series of pointed teeth beneath on the posterior margin of the anal plate. They remove portions of the skin and infest the interior of apples, and also attack the fruit of crabapples, hawthorns, wild and cultivated plums, prunes, and cherry; buds and terminal shoots are also infested. There are normally two broods with but a single generation in the most northern limits. Larvæ of the second brood hibernate. The codling moth sprays usually control the pest on apples.

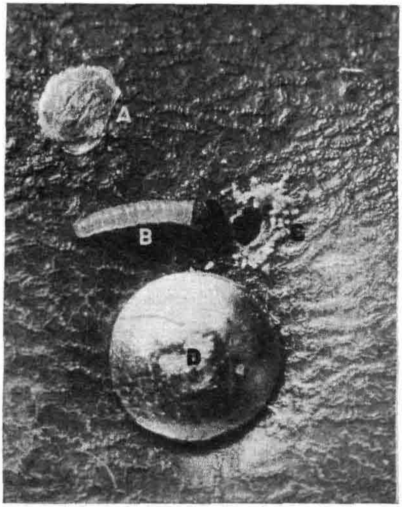


FIG. 605.—The codling moth, *Carpocapsa pomonella* (Linn.). A, egg-shell; B, newly hatched caterpillar eating into an apple; C, hole made by the caterpillar and particles of apple skin rejected by the larva; D, head of an ordinary pin for comparison in size. (Photo furnished by Ralph H. Smith.)

The Douglas fir tortricid, *Laspeyresia bracteatana* (Fernald), infests the cones of Douglas fir in Oregon and California and often destroys the seed crop. It also attacks the scales of Santa Lucia fir in Southern California. *L. pallidibasalis* Heinrich feeds in the cones of white fir in California and Oregon.

The Catalina cherry moth, *Melissopus latiferreanus* (Wlshm.)[1] (Fig. 604), has an expanse of 12–15 mm. and is pale or dusky bronze or terra cotta with two coppery areas at the tips of the fore wings. The eggs are disc-like and whitish and are laid on the fruit of the Catalina cherry and on green cynipid oak galls. The caterpillars are

[1] E. J. Branigan. *Mthly. Bul.*, Cal. State Com. Hort., 4, p. 528, 1915; 5, p. 36, 1916.

white or pinkish and 18–20 mm. long when mature. They infest the seeds of the Catalina cherry in Southern California and have been taken in large numbers in the large green galls of *Andricus californicus* (Bassett), on blue oak in Central California by the writer, the adults being determined by August Busck. The larvæ hibernate in a cocoon in the soil under Catalina cherry, but it has not been ascertained if they leave the oak galls or hibernate within. There is but one brood. The range is given from Maine to California.

The codling moth, *Carpocapsa pomonella* (Linn.),[1] (*Tinea*) (Figs. 605–609), is the most injurious insect to apples and pears in Europe, North America, and wherever these fruits are commercially grown. It was introduced

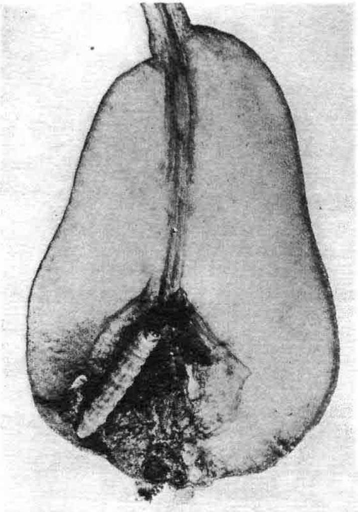


FIG. 606.—Larva of the codling moth, *Carpocapsa pomonella* (Linn.), and burrow in a pear.

into the United States prior to 1819 and into California in 1872. The adults have a wing expanse of 15–22 mm., and are bluish gray in color, harmonizing well with the gray bark of the host plants. The fore wings are brownish with several gray or paler cross lines and near the tip of each is a coppery spot in which are two irregular golden lines; the hind wings are paler with fringed borders. The eggs are disc-like and about the size of a pin head, transparent white when first laid and becoming reddish and dark with the development of the embryo. The minute newly hatched larvæ (Fig. 605, B) are whitish with large black heads. When mature they are

[1] European entomologists have adopted the genus *Cydia* for this species.

white, yellow or pinkish, with the head, shield, and anal plate brown; nearly naked or with a few hairs arising from areas of minute pigmenttation, clearly visible with a hand lens; and attain a length of from

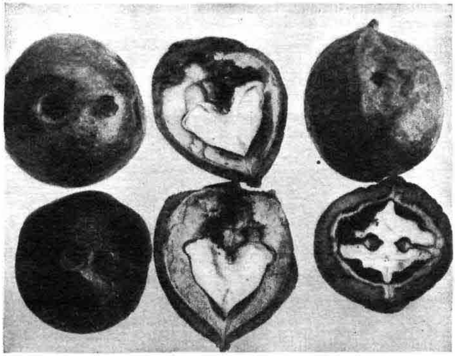


FIG. 607.—Green English walnuts showing injury by caterpillars of the codling moth, *Carpocapsa pomonella* (Linn.).

25–35 mm. Pupation occurs in a white felty cocoon in any convenient place on the tree or other objects. The pupa is about 13 mm. in length and varies from yellow to dark brown. The species is from two to four

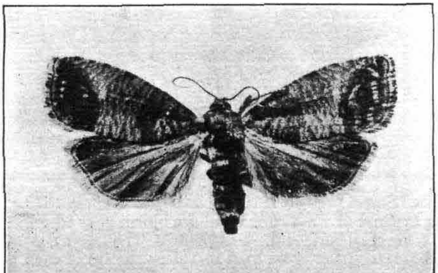


FIG. 608.—Adult codling moth, *Carpocapsa pomonella* (Linn.).

brooded depending upon the latitude. The winter is passed in the larval stage within the cocoons on the trees in such protected places as under the bark, in wounds, crotches, and so forth; in the weeds, grasses, or litter on

the ground; or in boxes, storehouses, or other convenient objects. In the spring the larvæ enter the pupal stage, which requires about twenty days. The first moths emerge about the time the apples begin to leaf out and bloom, and various generations continue to appear at intervals until harvest. The first eggs are laid mainly on the leaves and twigs and a few on the very young fruit, while those of succeeding generations are usually placed on the green fruit. The larvæ of the first brood feed largely on the leaves, while those following enter the fruit from the calyx end or sides. About twenty days are required for the development of the caterpillars and about fifty days for a complete life cycle. In the west there are two or three broods in much of the range with a partial fourth in the southern portions. The injury to the fruit of apples and pears by the larvæ or worms

FIG. 609.—Spraying walnut trees with high-powdered machine and spray guns to control the codling moth.

is familiar to all and consists in one or several holes through the skin and a mass of frass about the core. Crabapples, apricots, cherries, loquats, peaches, plums, haws, and similar fruits are also occasionally attacked. The green nuts of English walnuts (Fig. 607) are also commonly and often seriously infested in Southern Europe and in California. There are very many natural enemies of the codling moth, but their combined efforts are of little avail in the control of the pest under orchard conditions. The carabid beetles, *Pterostichus californicus* (Dej.), *Calathus ruficollis* Dej., and other species, commonly prey on the larvæ which fall on the ground (California). The dermestid beetle, *Perimegatoma variegata* Horn, devours the pupæ in the cocoons (California); the larvæ of the clerid beetle, *Cymatodera æthiops* Wolcott, kill great numbers of the larvæ hibernating on the trees (New Mexico).[1] Artificial control measures depend entirely upon the locality. The standard remedy is three pounds of powdered arsenate of lead to 100 gallons of water applied in a rather coarse spray at

[1] D. E. Merrill, *Jour. Econ. Ent.*, 10, p. 461, 1917.

a pressure of 250 pounds. The calyx spray should be applied when the petals begin to fall. In severe infestations this should be repeated in seven to ten days. The first cover spray should begin four weeks from the time of beginning the first calyx spray. This should also be repeated in seven to ten days where warranted. A second cover spray may be applied not later than five weeks before picking time, with a light application. From three to seven applications are regularly made in many of the most important apple and pear growing districts in the west. On walnuts five pounds of basic powdered arsenate of lead to 100 gallons of water are recommended; the first application to be made from May 25th to June 20th, and the second during the latter part of July. A very important adjunct to spraying is orchard sanitation to reduce the numbers of hibernating larvæ. The immediate destruction of all windfalls, the painting over of large pruning wounds, the elimination of weeds and refuse in and about the orchards are all necessary to success in the control of

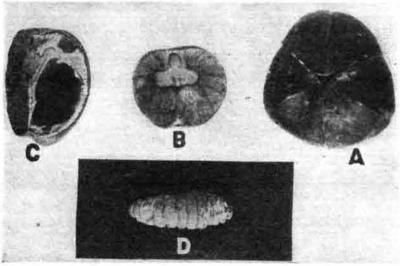


FIG. 610.—The Mexican jumping bean moth, *Carpocapsa saltitans* Westwood. A, the so-called Mexican beans or seeds of *Sabestiania* as they occur on the plant; B, one of the three divisions of the seed known as a bean; C, bean from which mature larva has been removed after it had eaten the kernel. D, mature larva or caterpillar.

this insect. Dusting with arsenate of lead gives satisfactory results only when done thoroughly and repeatedly, because the wind soon carries the thin coat of poison away.

The cypress cone moth, *Carpocapsa cupressana* (Kearfott) (*Cydia*), is a dark smoky brown moth with yellow and copper markings and an expanse of 14–16 mm. The larvæ are dull reddish or green and commonly infest the green cones of the Monterey and Sargent cypresses, and also attack the bark of the trunks and limbs particularly in the forks, and cause deformations and often an exudation of resin. The species is common in the San Francisco Bay region, California. *Carpocapsa toreuta* (Grote) commonly infests the cones of yellow pine in Colorado, California, and Oregon.

The Mexican jumping bean moth, *Carpocapsa saltitans* Westwood (Fig. 610), is a small gray moth with darker mottlings on the fore wings. The small robust yellow larvæ attain a length of 3–5 mm. and infest the seeds of many species of *Sabestiania* in Mexico. The larvæ remain in the seeds during the winter. They frequently throw themselves from one wall of the seed to the other causing the seeds to jump. This action is hastened by placing the seeds in the sun or on a warm object. Pupation also occurs within the seeds and the adults emerge through a small circular hole. Jumping

beans are also called Devil's beans, jumping seeds, and "Bricandores" and are imported in considerable numbers into the United States and particularly California, Arizona, New Mexico, and Texas, where they are sold as curiosities by street venders with many fabulous tales about them. They cease to jump or die when the larvæ change into pupæ.

TORTRICIDÆ.[1] Leaf Rollers, Tortricids.

The fruit tree leaf roller, *Archips argyrospila* Walker (*Cacœcia*)[2] (Figs. 611, 612), has an expanse of 20–25 mm., and the prevailing color is fawn

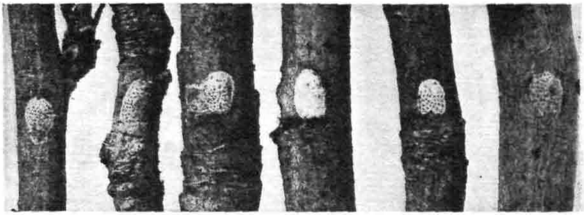


FIG. 611.—The egg masses of the fruit tree leaf roller, *Archips argyrospila* Walker, on prune twigs. The eggs are covered with a waterproof cement from which the minute larvæ emerge through very small holes.

or rusty brown with a prominent light spot on the costal margin near the middle of the fore wings and other spots irregularly placed. The adults appear from May to August and lay the eggs in irregular flat masses which are entirely covered with a whitish or grayish cement which often becomes nearly black. The eggs occur chiefly on the bark of the trunk and limbs

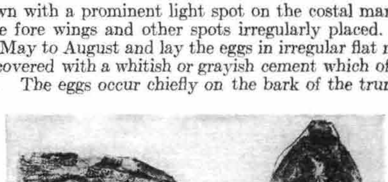


FIG. 612.—Adult and fore wing of the fruit tree leaf roller, *Archips argyrospila* Walker.

of the trees where they remain exposed all winter and hatch in March, April, and May. The caterpillars at once begin to feed on the green fruit and foliage and the unfolding leaves are rolled and tied together with web-

[1] W. D. Kearfott, "New N. A. *Tortricidæ*." *Trans. Am. Ent. Soc.*, 30, p. 287, 1904; 33, p. 1, 1907.

[2] C. P. Gillette and G. P. Weldon, *Fourth Ann. Rept. State Ent. Colo.*, p. 134, 1913; *Circ.* 5, Office of State Ent. Colo. 1912. Complete.

G. P. Weldon, *Mthly. Bul.*, Cal. State Hort. Com., 2, p. 637, 1913.

J. B. Gill, Bul. 116, pt. 5, Bur. Ent. U. S. Dept. Agr. 1913.

bing so as to form compact hiding places. When abundant the trees may be entirely defoliated over large areas and extensive webs spun over the leaves, fruit, and branches of the trees, and on the ground beneath. When mature the caterpillars are various shades of green with shining brown or black head and shield, and pale tubercles at the bases of the body hairs. They attain a length of 20–25 mm. and when disturbed wriggle violently backwards into the hiding places or fall to the ground. Pupation occurs within the leaf rolls. There is but one brood annually. The caterpillars are, perhaps, most serious to the fruit and foliage of the apples, but also freely attack alfalfa, apricot, ash, blackberry, box elder, cherry, currant, elm, gooseberry, locust, loganberry, oak, onion, pear, plum, poplar, prune, quince, raspberry, rose, English walnut, and willow. The species occur in New Mexico, Colorado, Montana, Idaho, Utah, Nevada, California, Oregon, Washington, and British Columbia. Artificial control consists in the application of miscible oil or crude oil emulsion sprays during the winter to kill the eggs. Arsenate of lead powder at the rate of three pounds to 100 gallons of water gives some control over the larvæ during the spring and summer.

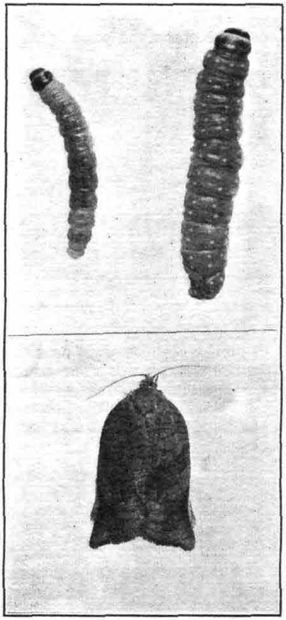


FIG. 613.—Caterpillars and adult of the oblique-banded leaf roller, *Archips rosaceana* (Harris).

The oblique-banded leaf roller, *Archips rosaceana* (Harris) (*Cacœcia*) (Fig. 613), is reddish brown, the front wings with many fine irregular darker lines and a wide dark oblique band across the middle. The eggs are laid in greenish masses and overlap like fish scales on the branches of the hosts. The appearance of the larvæ, the habits, and life history are similar to those of the preceding species. The hosts are apple, apricot, ash, basswood, beans, birch, blackberry, box elder, burdock, carnation, celery, cherry, clover, cotton, currant, dogwood, geranium, gooseberry, hawthorn, hazelnut, honeysuckle, horsechestnut, knotweed, lilac, loganberry, maple, oak, peach, pear, plum, poplar, prune, horseradish, ragweed, raspberry, rose, smartweed, strawberry, sumach, sunflower, thistle, and verbena. The distribution includes much of North America and is the same as for the preceding species in the west.

The cherry tree tortrix, *Archips cerasivorana* (Fitch) (*Cacœcia*), is a common eastern pest to wild and cultivated cherry, which ranges west into Montana, Idaho, Washington, British Columbia, and California. The larvæ are blackish and web the leaves. They rarely also infest apple. **The box elder leaf roller,** *Cacœcia semiferana* (Walker), infests the box elder in Colorado and ranges east to the Atlantic.

Cacœcia negundana Dyar also defoliates box elder in Utah, and Colorado and ranges to the Atlantic. **The apple pandemis,** *Pandemis pyrusana* Kearfott, has an expanse of 22–26 mm., and is pale ochreous brown with yellow markings. The eggs are pale greenish and laid overlapping in masses usually on the leaves. The caterpillars are brownish green and are often confused with those of the fruit tree leaf roller and the oblique banded leaf roller. They feed on the leaves and fruit of apple in California.

The orange tortrix, *Tortrix citrana* Fernald (Fig. 614), is a fawn or gray colored moth with darker mottlings on the fore wings and an expanse of 18–22 mm. The eggs are cream colored, disc shaped, with netlike sculp-

FIG. 614.—Caterpillar of the orange tortrix, *Tortrix citrana* Fernald, and work in orange.

turings on the surface. They are laid overlapping in masses on both surfaces of the leaves and hatch in about twelve days. The larvæ are dirty white with brown head and shield. They normally web and feed on the leaves of goldenrod, oaks, black walnut, and willow, and have worked over to acacia, apricot, asparagus, begonia, cineraria, Job's tears, eucalyptus, ferns, geraniums, Jerusalem cherry, lantana, lavender, orange, pentas, rose, and wandering Jew. The most serious injury is to the ripe fruit of the orange which is entered through the peel beneath which the larvæ feed, seldom going deep into the pulp. Considerable damage is thus done in some years in Southern California. The species occurs throughout California and is also recorded in Brazil.[1] *Sparganothis tinctana* Walker

[1] J. Bondar, *Rev. Applied Ent. Ser.* A, 4, p. 20, 1916.

(*Platynota*)[1] is a very similar species. The larvæ web and feed on the leaves and fruit of the orange in Southern California. They are also general feeders and attack many other plants. The species occurs in Texas also and probably the intervening territory, as well as in Mexico and Central America.

The apple skin worm, *Tortrix franciscana* (Wlshm.) (Figs. 615, 616), is very similar in the adult stage to the fruit tree leaf roller, but has darker

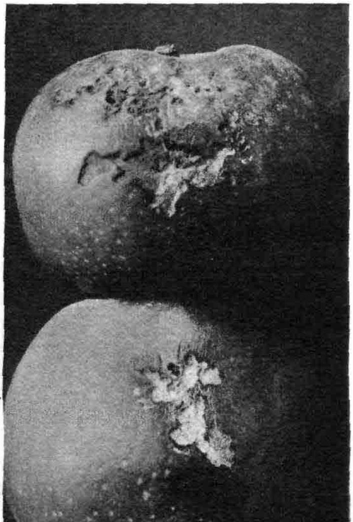


FIG. 615.—Apples showing the characteristic work of the apple skin worm, *Tortrix franciscana* (Wlshm.). (Photo by D. Penny.)

markings and is smaller. The eggs are yellow and laid on the leaves. The larvæ vary from pale green or yellowish to brownish and have the head and shield slightly darker, but not black. They feed on a number of plants including chapparal broom, carnations, cyclamen, ivy geranium, lambsquarters, lupines, morning glory, nettle, and weeds, but are most destructive to the foliage and particularly to the fruit of apples. The skin of the fruit

[1] R. S. Woglum, *Mthly. Bul.*, Cal. State Dept. Agr. 19, p. 341, 1920.

is usually removed around the calyx or stem end or at points of contact. This work may start in the orchards, but the larvæ continue to feed on the fruit in storage unless it is placed in cold storage. A web is usually spun over the end under which the caterpillar operates. So far this type of injury had been confined to the apple-growing sections of the San Francisco Bay region, California, and has often been serious.

The spruce budworm, *Harmologa fumiferana* (Clemens) (*Tortrix*),[1] has an expanse of 19–22 mm., and is fuscous, the fore wings being brownish

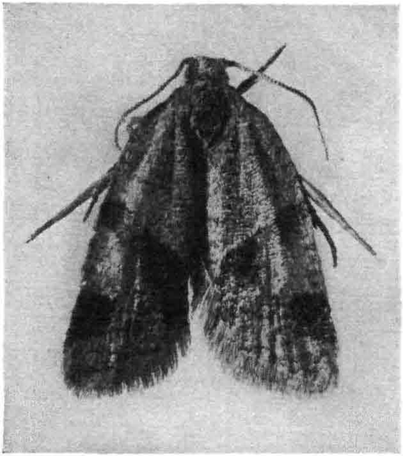


FIG. 616.—Adult of the apple skin worm, *Tortrix franciscana* (Wlshm.).

marked with darker streaks. The adults appear in July and August and deposit the pale green, flat eggs which overlap in masses on the undersides of the needles. They hatch in ten days and the pale green or yellowish larvæ begin to feed on the needles of the terminal shoots, usually spinning a web about the needles and bud scales as a place of protection. When full grown they are dark brown. They are often present in enormous numbers and are responsible for great damage to the forests of white fir, Douglas fir, Engelmann spruce, western larch, western hemlock, white pine, yellow pine, lodgepole pine, and western cedar. The larvæ hibernate in the nests

[1] O. A. Johannsen, *Spruce Bud Worm and Spruce Leaf Miners.* Bul. 210, Maine Agr. Exp. Sta., 1913.
F. C. Craighead, "Relation Between Mortality of Trees Attacked by the Spruce Budworm and Previous Growth." *Jour. Agr. Research*, 30, pp. 541–555, 1925.
This species is listed under the genus *Cacœcia* by some recent writers.

in the terminal shoots and mature the following June and July. The species occurs throughout the northern parts of the United States and in Canada and ranges west to the Pacific, through Montana, Yellowstone National Park, Idaho, and British Columbia.

The cranberry blackhead fireworm, *Rhopobota nævana* (Hübner) (*Tortrix*), in the adult stage, are moths which are gray mottled brown and 6–7

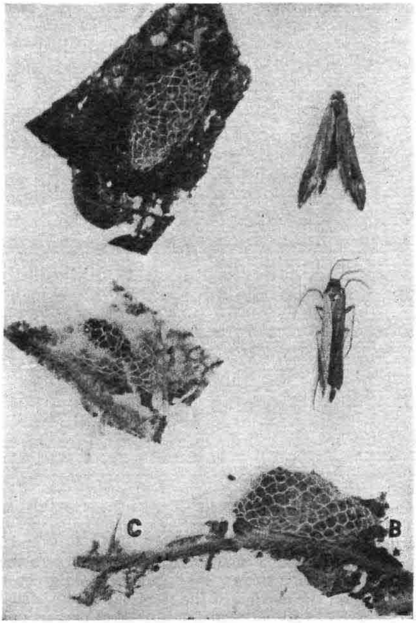


FIG. 617.—The blackberry leaf skeletonizer, *Schreckensteinia festaliella* Hübner. A, adult; B, cocoon; C, pupal skin.

mm. long. The eggs are slightly elliptical smooth, pale to deep yellow, and 0.65 mm. in diameter. The larvæ are dark greenish yellow, dusky olive green above, the head and thoracic shield shining black, and when full grown are 6.5 mm. long; the pupæ are pale amber yellow, 5–5.5 mm. long, and enclosed in a white cocoon. The adults appear in June and are to be found in the bogs until September and November. They make short jerky

flights and cement the eggs on the undersides of the leaves. The newly hatched caterpillars may act as leaf miners for a short time after which they attack the leaves about the terminal fruit buds, completely enclosing them with a web. They also feed on the buds, leaves, blossoms, and developing fruit, and when abundant cause the cranberry bogs to appear fire-swept. There are three generations a year, the larvæ of the first appear in May and June, those of the second are most numerous the latter part of July, and those of the less distinct third generation occur in the later part of the season appearing first in August. All generations overlap to some extent. Pupation occurs among the leaves under the vines. The winter is passed in the egg stage. The known host plants are the cultivated cranberry and the native western cranberry. This insect occurs in all the cranberry bogs in Washington and Oregon, as well as in many eastern bogs from whence it has been undoubtedly introduced on cuttings. The most effective remedy is 40 per cent nicotine sulfate at the rate of 1 part to 800 parts of water with the addition of 4 pounds of fish-oil soap to every 100 gallons. This material is used at the rate of about 300 gallons per acre, and three to four applications before the middle of July may be necessary to secure complete control.[1]

CARPOSINIDÆ.

The prune limb borer, *Carposina comonana* Kearfott, has an alar expanse of 16–18 mm. and is gray with the abdomen yellowish, the fore wings brownish gray with white lines and spots, and the hind wings purplish gray. The larvæ are whitish or pinkish and attain a length of 12–14 mm. Numbers were taken in the healthy limbs of French prune which were top worked on large apricot trees, and were sufficiently numerous and injurious to kill many of the grafts, although they were several years old and had attained a diameter of from two to three inches. The only injury noted was in a single orchard at Santa Clara, California. Prune trees not top worked on apricot were not infested in the same orchard.

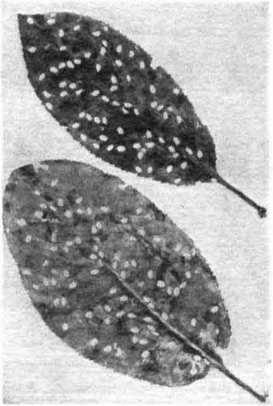


FIG. 618.—Madrona leaves showing the work of the larvæ of the madrona shield bearer, *Coptodisca arbutiella* Busck.

HELIODINIDÆ.

The blackberry leaf skeletonizer, *Schreckensteinia festaliella* Hübner (Fig. 617), is a minute silvery gray or bronze moth with a few cloudy or dusky markings on the basal portions of the fore wings. The small caterpillars are pale green and entirely beset with many long stout whitish spines. They feed chiefly on the upper epidermis causing large holes or entirely skeletonizing the leaves of cultivated blackberry and related plants. Pupation occurs in a delicate silk netlike cocoon on the undersides of the leaves. The brown pupæ are plainly visible through the meshes. The pupal skin is almost entirely withdrawn from the cocoon when the adult emerges. This species is European in origin and has been taken by S. H. Essig only on blackberry at Ventura, Cali-

[1] H. K. Plank, Bul. 1032, Bur. Ent. U. S. Dept. Agr. 1922.

fornia, where it was quite injurious in a small home garden. The larvæ are easily killed by spraying with two pounds of powdered arsenate of lead to 100 gallons of water as soon as they appear in the spring.

HELIOZELIDÆ. Shield Bearers.

The madrona shield bearer, *Coptodisca arbutiella* Busck (Figs. 618, 619), is a minute species with a wing expanse of 5 mm., dark silvery gray, with the apical halves of the fore wings brilliant golden enclosing two large triangular silvery spots, and with a black apical patch. The very small larvæ mine the leaves of madrona, and when mature cut out regular flattened, elliptical cases in which pupation occurs. The leaves may be entirely perforated with these holes. The winter is spent as larvæ or pupæ in the cases and the adults appear in the spring. The species is native and ranges from California

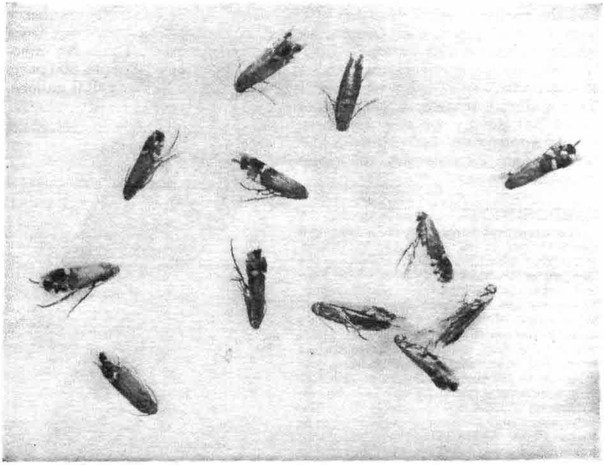


FIG. 619.—Adults of the madrona shield bearer, *Coptodisca arbutiella* Busck.

along the coast into Washington. A species attacking poplars in a similar way has been received from Imperial County, California, and leaves of wild grape have been received from Colorado with larger elliptical holes in them.

PLUTELLIDÆ.

The diamond back moth, *Plutella maculipennis* Curtis, is the best known member of this family, having a wide distribution in Europe and North America. The moths have an expanse of 18–20 mm., and are gray or brownish with white marks on the costal margin of each fore wing which give the form of a white diamond when the wings are folded. They appear in April and continue throughout the summer, there being from four to seven generations a year. The minute disc shaped, pale green or yellow eggs are laid singly on both sides of the leaves. The young larvæ work as miners

beneath the epidermis, but when nearly mature they feed externally and remove one of the epidermal layers only or eat holes into the leaves. Pupation takes place in a delicate white cocoon on the leaves or in rubbish nearby. A life cycle requires from two to seven weeks. Cabbage is the preferred host, but brussels sprouts, cauliflower, horseradish, kale, mustard, radish, rape, stocks, sweet alyssum, turnips, and other cruciferous plants are freely attacked. Onions are reported as a host in Russia. The species is reported in New Mexico, Colorado, Montana, California, Nevada, Oregon, Washington, and British Columbia in the west. Good control is obtained by spraying with 1 part of 40 per cent nicotine sulfate to 600 parts of water to which five pounds of hard soap are added as a spreader. **The horseradish web worm,** *Plutella armoraciæ* Busck,[1] has an expanse of 16–18 mm., and is white with yellow and ochreous markings and black spines on the undersides of the white tarsi. The immature forms are similar to those of the preceding species, but the larvæ web the leaves together. They feed on horseradish in Colorado. Hibernation occurs as larvæ among dead leaves or in the soil. Control measures are the same as for the preceding species. *Euceratia castella* Wlshm. is a beautiful, small, pure white moth which regularly appears about grasses in the evenings, for three or four days only in late April or early May at Berkeley, California. The hosts are unknown. *Abebæa subsylvella* (Wlshm.) commonly infests the foliage of live oaks along the coast from middle California into British Columbia.

YPONOMEUTIDÆ.[2] Twig and Leaf Miners.

The apple fruit miner, *Argyresthia conjugella* Zeller, is a small pale yellowish moth with the fore wings dark purplish brown, each marked with

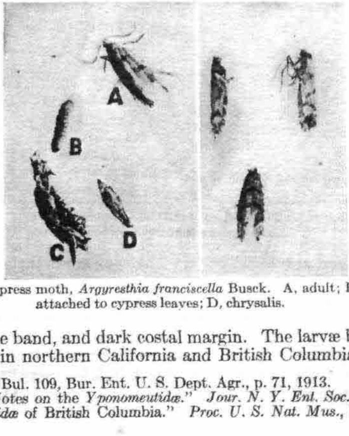


FIG. 620.—The cypress moth, *Argyresthia franciscella* Busck. A, adult; B, larva; C, cocoon attached to cypress leaves; D, chrysalis.

a darker oblique band, and dark costal margin. The larvæ burrow into the fruit of apples in northern California and British Columbia and a similar

[1] H. O. Marsh, Bul. 109, Bur. Ent. U. S. Dept. Agr., p. 71, 1913.
[2] A. Busck, "Notes on the *Yponomeutidæ*." *Jour. N. Y. Ent. Soc.*, 11, p. 45, 1903. "The *Yponomeutidæ* of British Columbia." *Proc. U. S. Nat. Mus.*, 27, p. 745, 1904.

injury occurs in Alaska. The species occurs in Europe and Japan and normally infests the fruits of mountain ash and bird cherry.

The cypress moths, *Argyresthia cupressella* Wlshm., *A. franciscella* Busck[1] (Fig. 620), *A. arceuthobiella* Busck, and *A. libocedrella* Busck, are all minute, pale golden yellow with darker maculations, and with an expanse of 7–9 mm. The caterpillars infest the tips of the twigs, and commonly mine the leaflets, causing them to die and fall. Webbing often accompanies the work. Pupation occurs in small white cocoons within the burrows or attached to the twigs. The first and second are common on Monterey cypress, Lawson cypress, Sargent cypress, and other species in the San Francisco Bay region of California; the third and fourth infest incense cedar in Oregon. *A. gœdartella* (Linn.) infests the terminals of the branches and catkins of birch and alder and is a European species now known in New Mexico, Colorado, California, and British Columbia in the west. *A. pygmæella* Hbn. is also a European species which attacks willows in British Columbia. *Zelleria gracilariella* Busck (*Z. ribesella* Busck) feeds gregariously on and webs the leaves of wild gooseberry in British Columbia.

COLEOPHORIDÆ (*Haploptiliidæ*). Case Bearers.

The cigar case bearer, *Coleophora fletcherella* Fernald, is a common pest to apple, pear, and quince in the Eastern States. The adults have an expanse

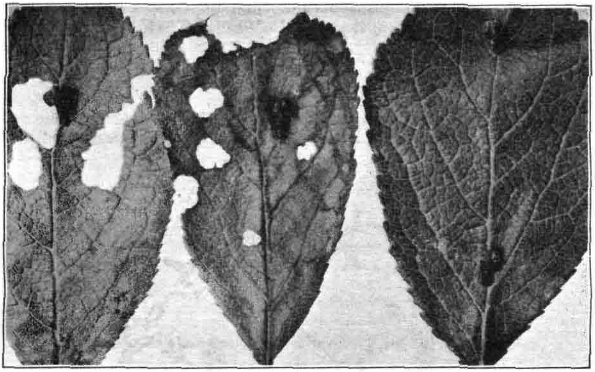


Fig. 621.—Larvæ and pupæ within cases of the California case bearer, *Coleophora sacramenta* (Heinrich), and work of larvæ on prune leaves.

of 13 mm. and are grayish in color. The eggs are cylindrical, pitted, and pale yellow in color. They are laid on the undersides of the leaves and hatch in 10–14 days in July and August. The small orange colored larvæ at first mine the leaves and later construct cigar-shaped cases in which they live the remainder of the summer. In the late fall they migrate to the twigs where they hibernate. In the spring they begin to feed on the opening buds and young leaves. Pupation occurs within the cases in May and June.

[1] E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed., p. 453, 1915. This is *A. franciscella* Busck.

There is a single generation. This insect is reported common in the apple orchards of British Columbia and is controlled by the first spray for the codling moth.

The California case bearer, *Coleophora sacramenta* (Heinrich)[1] (Figs. 621, 622), is a beautiful pale bluish white moth, the fore wings with minute brown scales and the hind wings, dull gray, and with an expanse of 15 mm. The orange colored larvæ bear a peculiar blackish case which is greatly widened at the posterior end with wing-like side projections and 8–10 mm. long. There is but one generation annually. The larvæ hibernate within the very small cases on the bare twigs of the host trees and eat ragged holes in the leaves in the spring. Pupation occurs in April, May, and June, and the adults appear in June and July and lay eggs on the leaves. The eggs are reddish brown, ridged, and the shape of an inverted teacup. The normal host is willow, but the insect commonly infests almond, apricot, apple, cherry, peach, pear, plum, and prune in the San Francisco Bay region, California. A spray compound composed of two pounds of arsenate of lead to 100 gallons of water, or dusting with a mixture of one pound of arsenate of lead to four pounds of hydrated lime gives satisfactory control. **Volck's case bearer,** *Haploptilia volcki* (Heinrich)[2] (*Coleophora*) (Fig. 623), is a silvery white and ochreous moth with an expanse of 15 mm. These moths resemble somewhat the adults of the cigar case bearer but are larger and have white markings on the legs and abdomen. The eggs are pale yellowish green, nearly hemispherical and deeply ribbed, and are laid on the undersides of the leaves. The dark brown caterpillars at first mine within the leaves and later construct a case 7–9 mm. long, which is usually brown and ragged in outline often with a conspicuous tooth-like projection on the back of the anterior end. After the formation of the case, the larvæ eat a hole usually through the lower epidermis of the leaf and mine out the interior as far as they can reach, thus producing large blotch mines which are often confluent. They also eat holes in the leaves as do the

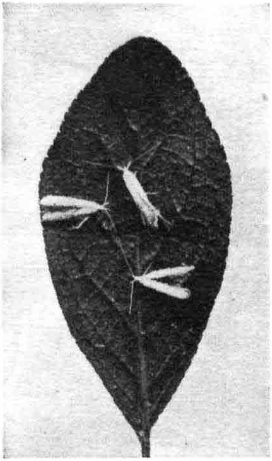


FIG. 622.—Adults of the California case bearer, *Coleophora sacramenta* (Heinrich), resting on a prune leaf.

[1] C. Heinrich, *Ins. Insci. Mens.*, 2, p. 145, 1910. Orig. desc.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed., p. 450, 1915.
W. M. Davidson, *Jour. Econ. Ent.*, 11, p. 446, 1918.
[2] W. H. Volck, *Mthly. Bul.*, Cal. State Com. Hort., 6, p. 463, 1917.
C. Heinrich, *Proc. Ent. Soc. Wash.*, 19, p. 135, 1917. Orig. desc.

preceding species. They migrate to the limbs and twigs in the fall and hibernate in the attached cases. Feeding starts on the developing leaves, and on the young fruit in the spring. Pupation occurs within the cases in May and June, and adults appear and lay the eggs in June and July. There is but a single generation a year. Apple is the only known host; the normal

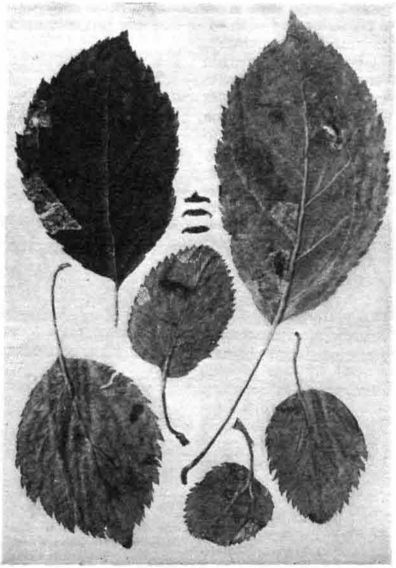


FIG. 623.—Volck's case bearer, *Haploptilia volcki* (Heinrich). Cases of pupæ and work and cases of larvæ on apple leaves.

food plant is probably willow. The species occurs in the apple orchards of the San Francisco Bay region, California. Control is difficult because of the mining habits of the larvæ, but an early application of arsenate of lead as recommended for the preceding species when the larvæ are feeding on the buds and young fruit, greatly aids in reducing severe infestations.

ELACHISTIDÆ.[1]

The yerba santa gall moth, *Cœlopœta glutinosi* Wlshm., is a small gray and fawn colored moth, the fore wings sprinkled and mottled ochreous and with an expanse of

[1] A. Busck, "*Elachistidæ* from British Columbia." *Proc. U. S. Nat. Mus.*, 27, p. 767, 1904.

12 mm. The larvæ make large bladder-like galls which start at the midribs of the leaves of yerba santa or mountain balm and occupy nearly the whole surface, causing the leaves to curl. The species occurs in central and northern California.

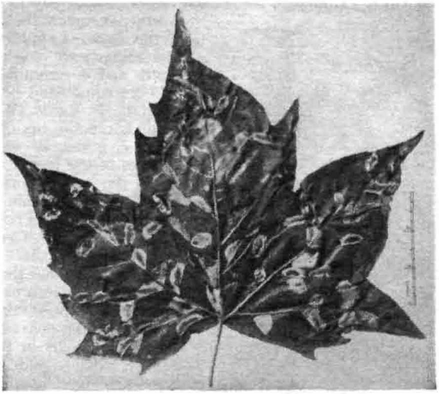


FIG. 624.—Mines of the larvæ of *Phyllonorycter felinella* Heinrich, on sycamore leaf. Many of the mines contain larvæ and pupæ.

TISCHERIIDÆ. Leaf Miners.

The apple leaf miner, *Tischeria malifoliella* Clemens, is a small dark gray and brown moth, the larvæ of which make trumpet-like mines in the leaves of apple. There are several generations, the larvæ of the last hibernating in the fallen leaves on the ground. This eastern insect is reported from Oregon in the west. *T. immaculata* Braun mines the upper surfaces of the leaves of Catalina cherry in California and *T. ambigua* Braun, *T. bifurcata* Braun, and *T. ceanothi* Wlshm. all mine the leaves of ceanothus in California.

FIG. 625.—Work of the apple skin miner, *Marmara pomonella* Busck, on apple.

GRACILARIIDÆ.[1] Leaf Blotch Miners.

The members of the large genera *Phyllonorycter* and *Cameraria* (*Lithocolletis*)[2] are very small moths, the larvæ of which are chiefly blotch miners on leaves of all kinds of annuals, perennials, and deciduous and evergreen shrubs and trees. **The apple leaf blotch miner,** *Phyllonorycter cratægella* (Clemens), mines the undersides of the leaves of apple, hawthorn, and wild cherry in the Eastern States and is common on apple, wild crabapple, and hawthorn in Oregon. *P. ledella* (Wlshm.) infests Labrador tea, the mines often occupying the entire upper surfaces of the leaves. It occurs along the coast north of San Francisco in California. *P. incanella* (Wlshm.) mines both sides of alder leaves in Central and Northern California. *P. arbutusella* (Braun) mines the leaves of madrona in California. *P. tremuloidiella* (Braun) mines the undersides of the leaves of aspen and other poplars in British Columbia, Idaho, and California. *P. salicifoliella* (Chambers) makes tentiform mines on the undersides of the leaves of cottonwood, poplars, and willows in Colorado, Arizona, and California, and probably occurs in many other States. *P. apicinigrella* (Braun) mines the undersides of the leaves of willow in California. *P. felinella* Heinrich (Fig. 624) mines the undersides of the leaves and may entirely defoliate the western and European sycamore trees in central California. The adults have an expanse of 7.5 mm., are golden yellow with white markings, and appear in June. *Cameraria gaultheriella* (Wlshm.) mines the upper surfaces of the leaves of salal in California and Oregon. This is one of the largest species, with a wing expanse of 10–11 mm., and is gray and golden saffron with white spots. *C. agrifoliella* (Braun) produces irregular whitish blotches on the upper surfaces of the leaves of the coast live oak in the San

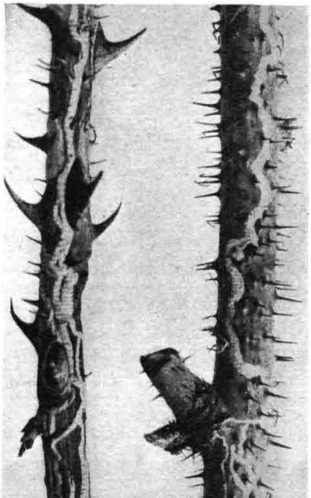


FIG. 626.—Work of the rose bark miner, *Marmara* sp., on rose and loganberry.

[1] C. R. Ely, "Revision of N. A. *Gracilariidæ* from the Standpoint of Venation." *Proc. Ent. Soc. Wash.*, 19, p. 29, 1917.

[2] A. F. Braun, "Rev. of N. A. Species of *Lithocolletis*." *Trans. Am. Ent. Soc.*, 34, p. 269, 1908.

Francisco Bay region, California. The adults are rich orange with white lines. *C. alnicolella* (Wlshm.) mines the upper surfaces of the leaves of alder in northern California. *C. nemoris* (Wlshm.) mines the whole surface and puckers the leaves of huckleberry in the northern coast countries of California. *C. umbellulariæ* (Wlshm.) forms large blister-like galls on the leaves of California laurel in northern California and southern Oregon. *Cremastobombycia grindeliella* (Wlshm.) mines both sides of the leaves of the gum plant in the San Francisco Bay region, California.

The apple skin miner, *Marmara pomonella* Busck (Fig. 625), makes a white winding mine on the skin of the fruit of apples in California, Oregon, Washington, and British Columbia. The adults are shining bluish black, the fore wings with white markings and the legs with white rings. The alar expanse is 8 mm. *M. arbutiella* Busck mines the leaves of madrona and is commonly associated with *Coptodisca arbutiella* Busck, in California, Oregon, and Washington. **The orange peel miner,** *Mar-*

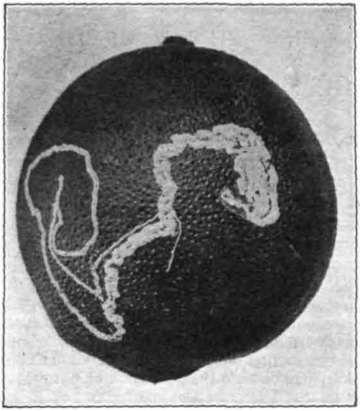


FIG. 627.—Work of the orange peel miner, *Marmara* sp., on orange.

mara sp. (Fig. 627), makes a conspicuous white winding mine on the peel of oranges in Southern California; another species mines the ripening fruit of prunes in many parts of California; and a very common species which may be the same as the one on apple, mines the epidermis of the cane of blackberries, loganberries, raspberries, and roses in California and Oregon (Fig. 626). *Gracilaria ferruginella* Braun makes tentiform mines on the undersides of the leaves of rhododendron and rolls the tips into cones, throughout California. *G. negundella* Chambers mines the undersides of the leaves of box elder in Colorado. *G. reticulata* Braun rolls the leaves of the coast live oak into a cone by a single fold of the tips to the undersides. It occurs in the San Francisco Bay region, California. The adults are yellow and reddish with an expanse of 14–15 mm.

The lilac leaf roller, *Gracilaria syringella* Fabr., is a small slender gray moth which is often abundant on the host plants chief of which are lilacs, privets, and ash trees. The eggs are laid in small batches on the undersides of the leaves and the larvæ first

mine and later roll the leaves and are often responsible for serious damage. There are several generations a year, the larvæ of the last brood hibernate in cocoons in the ground in cracks or in dead rolled leaves. This common European species was first discovered in America in 1925 by M. J. Forsell who reports it in the Puget Sound region of Washington and British Columbia and who very kindly furnished the above information.

LYONETIIDÆ. Leaf Miners and Ribbed Case Makers.

The cotton leaf perforator, *Bucculatrix thurberiella* Busck [1] (Fig. 628), is the most important western member of this family. The adults are white with black markings on the fore wings, black leg bands, and a wing expanse of 7–8 mm. The larvæ are dirty white with reddish head, two dorsal rows of black dots, and prominent white body tubercles. They normally feed on the Arizona wild cotton, but are often serious pests to the cultivated cotton as well. They prefer weak plants and eat small holes in the leaves, often leaving only the large veins. The species occurs in the cotton belts of Arizona, the Imperial Valley, California, and adjacent territory in Mexico. Pupation occurs in a white ribbed cocoon 8–9 mm. long, attached

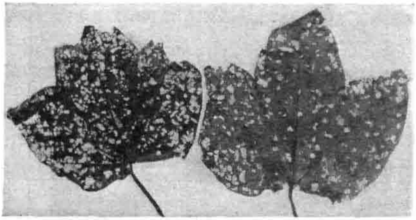


FIG. 628.—Work of the larvæ of the cotton leaf perforator, *Bucculatrix thurberiella* Busck, on cotton leaves.

to the leaves and stems of the plants. Dusting with calcium arsenate gives complete control. **The hollyhock leaf skeletonizer,** *B. althææ* Busck (Fig. 629), is a small tan and gray moth which mines or completely skeletonizes the leaves of ornamental hollyhocks and malva in California. **The oak ribbed case maker,** *B. albertiella* Busck (Figs. 630, 631, 671), is a very common leaf miner on the leaves of the coast live oak in California. The larvæ first act as miners, and after a molt under a thin white circular web, they feed from the outside and do much damage to the foliage. The pure white ribbed cocoons are familiar objects on the oak trees and also occur on neighboring plants and objects. The interesting little palisade of standing silken hairs is found about newly constructed cocoons. The adults are white with ochreous markings and have a wing expanse of 8 mm. Spraying with three pounds of powdered arsenate of lead to 100 gallons of water once or twice in the spring and early summer gives good control.

The cottonwood leaf miner, *Proleucoptera albella* (Chambers),[2] is a minute white moth with two yellow spots bordered with black near the tip of the fore wings. The

[1] A. Busck, *Proc. Ent. Soc. Wash.*, 16, p. 30, 1914. Orig. desc.
E. A. McGregor, *Jour. Econ. Ent.*, 9, p. 505, 1916.
[2] P. A. Glick, 14th *Ann. Rept.*, Ariz. Com. Agr. & Hort., p. 68, 1922.

minute ovate white eggs have a roughened surface and are laid in parallel rows on the leaves. The larvæ are lemon yellow and 5–6.5 mm. long when mature. They mine the leaves and may completely defoliate large cottonwood trees in Arizona. Pupation occurs in the tied leaves. A parasite, *Horismenus* sp., controls the insect normally. Raking up and burning the falling leaves affords control for shade trees.

Lyonetia candida Braun forms winding mines ending in a large blotch on the leaves of rhododendrons in California, Oregon, and Washington. *L. speculella* Clemens often completely defoliates ceanothus in British Columbia and also infests birches, wild plums, and cherries. It also occurs along the Atlantic.

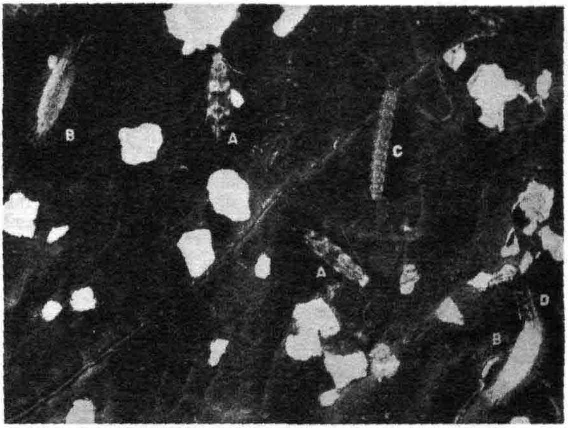


FIG. 629.—The hollyhock leaf skeletonizer, *Bucculatrix althææ* Busck. A, adults; B, cocoons. C, larva; D, skin of chrysalis partially withdrawn from cocoon when adult emerged; (Photo furnished by W. W. Jones.)

TINEIDÆ.[1] Tineid Moths.

The fungus moth, *Tinea defectella* Zeller, breeds in the large woody Polyporus fungi growing on cottonwood trees in New Mexico, Arizona, and California. *T. oregonella* Busck infests similar fungi growing on redwood and other coniferous trees in Northern California and Southern Oregon. *T. granella* Linn. is a cosmopolitan grain moth which infests cereals and cereal products throughout the world. The adults are brownish with silvery white spots and have an expanse of 8–14 mm. They have been reared in great numbers from wheat bran in Berkeley by the writer.

The clothes moths are not so common or well known in the west as in the Eastern States, but are nevertheless often serious pests in storage establishments, stores, and houses. The larvæ feed on wool, hair, furs, skins, feathers, and other dried animal matter. They are best controlled by

[1] A. Busck, "*Tineidæ* from British Columbia." *Proc. U. S. Nat. Mus.*, 27, p. 770, 1904.

Wm. G. Dietz. "Rev. of N. A. Genera and Species of *Amydriinæ* and *Tineinæ*." *Trans. Am. Ent. Soc.*, 31, p. 1, 1905.

packing with moth balls, camphor, cedar chips, or paradichlorobenzene, tightly wrapping the articles to prevent access by the moths; storage in well ventilated, light, and dry places; or placing in cold storage at a temperature of from 40° to 42° F. **The case making clothes moth,** *Tinea pellionella* Linn., has an expanse of 10–14 mm. and is grayish yellow with pale dark spots on the middle of the fore wings. The larvæ are dull white with head and shield brown, and live in portable cases constructed of wool, hair, and refuse, bound together with silken threads where pupation also occurs. **The webbing clothes moth,** *Tineola bisselliella* Hummel, is pale ochreous throughout with an expanse of 9–14 mm. The larvæ are not enclosed in a case, but web together the particles on which they feed. It is perhaps the most widely spread species and is the one most often taken in California. There are two or three broods a year. **The tapestry moth,** *Trichophaga tapetiella* (Linn.) (*Tinea*), is much larger than the two preceding ones, having a wing expanse of 40 mm. The color is creamy white or grayish with the basal third of the fore wings black. The larvæ form galleries through the masses of wool or hair upholstery, carpets, blankets, and other

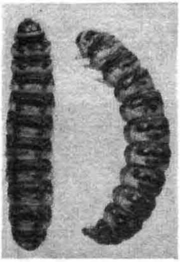


FIG. 630. — Caterpillars of the oak ribbed case maker, *Bucculatrix albertiella* Busck. Also see Fig. 671.

FIG. 631.—Cocoon of the oak ribbed case maker, *Bucculatrix albertiella* Busck, and palisade made by larva before constructing the cocoon. On leaf of the coast live oak.

food materials, and line them with silk. Because of its large size and the numerous burrows made, it is often a serious pest. It is rare in the west.

COSSIDÆ. Carpenter Moths.

The carpenter or goat moth, *Prionoxystus robiniæ* (Peck)[1] (Figs. 632–634), is a very large and destructive species. The adults have a wing expanse of 50–85 mm., and are mottled gray. The front wings of the male are dark gray and the hind wings ochre yellow or orange red lined with black. They

FIG. 632.—Larvæ of the carpenter or goat moth, *Prionoxystus robiniæ* (Peck), in portion of an apricot tree.

are only about half as large as the females. The adults appear in June and July and deposit the eggs in the cracks or crevices of the bark or in or near wounds or the openings of old burrows. The eggs are oval or elongated, slightly larger than a pin head, finely reticulated, dirty white or greenish and sticky. As many as 200–300 are laid by a single female. The larvæ immediately enter into the solid wood of the tree where they make large galleries which frequently result in the death of the host. When *mature they are white or pinkish with dark head and shield and brown*

[1] L. Childs, *Mthly. Bul.*, Cal. State Hort. Com., 3, p. 259, 1914.

spots at the bases of the scattering body hairs. They attain a length of 65 mm. Three years are required to complete a life cycle. The caterpillars are particularly destructive to the coast live oak in the San Francisco Bay region, California, but also attack other oaks, elms, poplars, cottonwoods, locusts, carob, ash, maple, willow, apricot, pear, and other ornamental and orchard trees. The distribution embraces the entire continent. In the west it is recorded in New Mexico, Colorado, Arizona, Nevada, and California. Caging the trunks of the trees with fine wire screen to prevent infestation has been worked out by H. E. Burke[1] for valuable ornamental trees. Injecting carbon disulfid into the openings of the burrows and plugging them with wet clay or mud is suggested by Childs for infested trees.

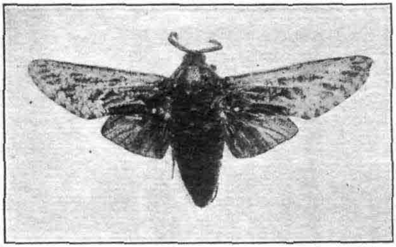


FIG. 633.—The male of the carpenter or goat moth, *Prionoxystus robiniæ* (Peck). (After Childs.)

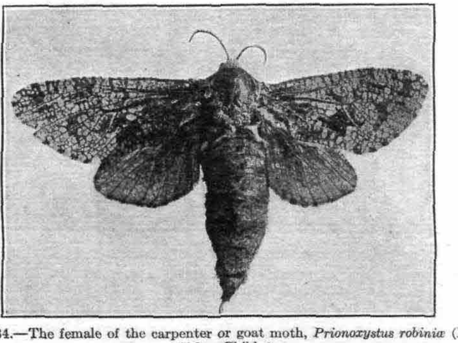


FIG. 634.—The female of the carpenter or goat moth, *Prionoxystus robiniæ* (Peck). (After Childs.)

The pine carpenter worm, *Givira lotta* Barnes and McDunnough, is a large white caterpillar attaining a length of 30 mm., which mines the rough outer bark of the bases of the main trunks of yellow pine in Colorado. *Acossus populi* (Walker) infests cottonwoods and poplars in California, Nevada, and British Columbia.

[1] *Jour. Econ. Ent.*, 13, p. 369, 1921.

NEPTICULIDÆ.[1] Leaf Miners.

This family consists of small leaf mining moths. *Nepticula canadensis* Braun mines the leaves of alder in British Columbia. *N. ceanothi* Braun and *N. punctulata* Braun mine the uppersides of the leaves of ceanothis throughout California, and the latter also infests the leaves of the California coffee berry in the Yosemite valley. *N. variella* Braun makes serpentine mines on the upper surfaces of the leaves of the valley oak in the San Francisco Bay region, California. *N. populetorum* Frey and Boll mines both sides of the leaves of cottonwoods and poplars in Southern California.

PRODOXIDÆ.[2] Yucca Moths.

The pronuba moths are responsible for the cross pollination of the yucca plants. The females have specially modified mouth parts to scrape together the sticky pollen from the stamens and carry it to another flower where they mount the pistil and oviposit through the wall of the ovary into the seed cavity. In making the transfer of the pollen the females are careful to rub it into the inner surface of the stigmatic tube, thus insuring a proper fertilization of the seeds in the ovary which serve as food for

FIG. 635.—Caterpillars of *Hepialus* sp. and work on the roots of raspberries.

the developing larvæ hatching from the eggs. Practically all of the species of *Tegeticula* (*Pronuba*), excepting one species which inhabits the South Atlantic States, occur in the Southwestern States and Mexico.

Members of the genus *Prodoxus* breed in the bases of the seed capsules, the flower stems, or in the main stems of the yucca plants and the agave or century plants. They are also largely confined to the arid southwest where the host plants occur, and are commonly known as bogus yucca moths.

HEPIALIDÆ. Hepialid Moths.

The lupine stem caterpillar, *Hepialus behrensi* Stretch (*H. sequoiolus* Behrens), infests the main stems and roots of the tree lupine and rosilla or sneezeweed in the San Francisco Bay region. During the fall of 1922, the writer discovered a large caterpillar 35–45 mm. long, dusky greenish with yellowish brown head and shield and whitish body tubercles (Fig. 635). These caterpillars were entirely destroying the raspberries which were growing in the writer's garden on the Berkeley hills. The roots were wholly mined and the burrows extended into the bases of the stems. Specimens were identified by A. Busck as belonging to the genus *Hepialus*. No adults were reared, but it is more than likely that the species is the above one, inasmuch as lupines are abundant in the same locality.

[1] A. F. Braun, "*Nepticulidæ* of N. A." *Trans. Am. Ent. Soc.*, 43, p. 155, 1917.

[2] H. G. Dyar, "Rev. of N. A. Species of *Pronuba* and *Prodoxus*." *Jour. N. Y. Ent. Soc.*, 11, p. 103, 1903.

J. H. Comstock considers the above family as a subfamily of the *Incurvariidæ*.

CHAPTER XXVIII

HYMENOPTERA (Order)[1]

(*Hymen*, a membrane; *pteron*, wing)

Sawflies, Horntails, Gallflies, Parasites, Ants, Wasps, Bees

This is the largest and most specialized order of insects. The adults have a complex metamorphosis; biting, lapping or sucking mouth parts; normally four strong membranous wings, the front pair held to the hind pair by a series of hooks on the front margins of the hind wings which engage in a fold on the hind margin of the fore wings. On the other hand the adults may be wingless. In two suborders the first abdominal segment is fused with the metathorax thus appearing to be a part of it. The ovipositor is variously modified for inserting eggs in foliage, hard wood, the bodies of other insects, or as a sting. In many groups there is the very extraordinary phenomena of the repression of sex maturity, while parthenogenesis and the ability to form most wonderful plant galls are to be found in certain forms. The larvæ of the sawflies and horntails are caterpillar-like with true legs and often with a greater number of prolegs, but in most of the members the young are legless, maggot-like, blind, and with degenerate forms not at all like the very highly specialized parents. Pupation normally takes place in thin silken or parchment-like cocoons.

This is by far the most important beneficial order of insects, in spite of the losses incurred by the sawflies, horntails, and ants. Many of the bees are of very great value because of the pollination of many plants which would not otherwise set fruit or seeds, and in addition the honeybee is noted for the production of honey. The parasites help to maintain the balance of power in the insect world and keep down the injurious plant-destroying forms which would otherwise soon devastate all the plant life, causing all life to perish. So important is this rôle that the artificial rearing of parasitic enemies to assist in the control of the insect enemies of agricultural crops is now being practiced on a large scale in California, Hawaii, and many other parts of this country and the world. The social relationships of ants, bees, and wasps has long been a most interesting study and will be discussed later in this chapter.

The order is entirely too large to permit of more than the merest superficial study in a work of this character. Many references have already been made to most of the parasitic forms, so that a brief tabulation must suffice here.

[1] E. T. Cresson, "Synopsis of Families and Genera of *Hymenoptera* of America North of Mexico." *Am. Ent. Soc.*, 1887.

P. Cameron, *Biol. Cent. Am. Hymenoptera*, 1, pp. 1–487, 1883–1900; 2, pp. 1–413, 1888–1900.

W. E. Britton, H. L. Viereck, A. D. MacGillivray, C. T. Brues, W. M. Wheeler, S. A. Rohwer. "The *Hymenoptera* or Wasp-Like Insects of Connecticut." *Guide to the Insects of Connecticut.* Bul. 22, pt. 3, *Conn. State Geol. and Nat. Hist. Surv.* 1916.

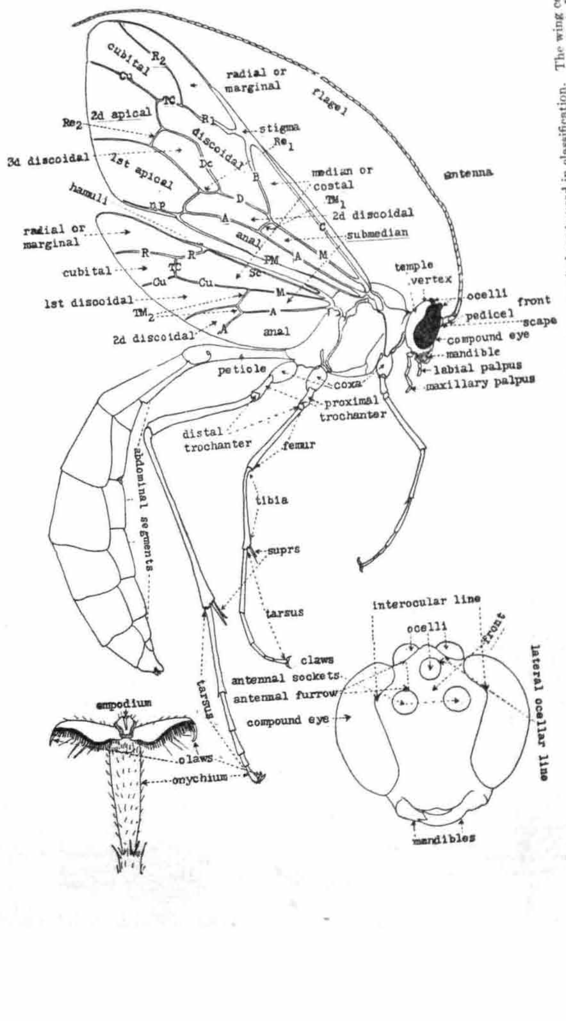


FIG. 636.—An ichneumonid fly, *Eremotylus macrurus* (Linn.), showing principal anatomical parts used in classification. The wing cells are named on the drawing. The veins are as follows. A, anal (1st A + 2d A); B, basal (M and m-cu); C, costal [costa (C) + Sc + R + M]; Cu, cubital ($M_1 + 2$ and $R_4 + 5 + M_1$); D, discoidal (1st abscissa, M_4; 2d abscissa M_3), Dc, discocubital; M, median (Cu and M_4); np, nervus parallelus; PM, posterior margin; R_1, basal half of radial or marginal (R_2); R_2, apical half of radial or marginal (R_2); Re_1, radial or marginal; Re_2, second recurrent (M_2); Sc, subcostal (Sc + R + M); Sd, subdiscoidal (m and M_2); Sm, submedian; TC, transverse cubital (r–m and Rs and R_4); TM_1, transverse median or nervulus ($M_4 + Cu_1$); TM_2, transverse median or nervulus of hind wing (M_3).

The writer is greatly indebted to L. O. Howard, S. A. Rohwer, R. A. Cushman, A. B. Gahan, H. L. Viereck, H. S. Smith, and R. M. Smith for determinations of reared specimens and for help in revising this manuscript.

KEY TO SUBORDERS

(After J. H. Comstock)

1. Base of the abdomen not slender but broadly jointed to the thorax............ 2
   Base of the abdomen constricted into a narrow pedicel........**Clistogastra** p. 777

2. Antennæ inserted between the eyes above the base of the clypeus with the bases of the antennæ exposed; front wings with the transverse part of vein M_2 (second recurrent) present or if wanting (*Hylotoma*) then R_4 (second transverse cubital) is present in the hind wings, which therefore have a closed submarginal cell; ovipositor either sawlike or a sturdy borer, never threadlike or capable of being coiled within the body..........................**Chalastogastra** p. 759
   Antennæ inserted below the eyes immediately above the mandibles under a transverse ridge, their bases concealed; front wings with the transverse part of M_2 (second recurrent) wanting; vein R_4 (second transverse cubital) in the hind wings wanting, therefore no closed submarginal cells; ovipositor threadlike and coiled within the mesothorax..........................**Idiogastra** p. 777

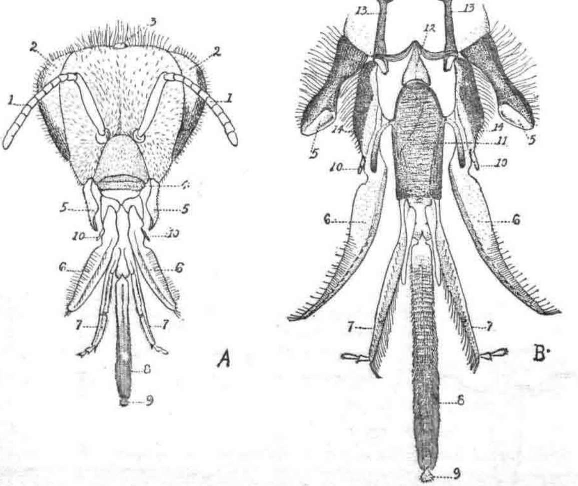


FIG. 637.—Head and mouth parts of the honeybee, *Apis mellifica* Linn. A, front of the head; B, mouth parts. 1, antennæ; 2, compound eyes; 3, ocellus or simple eye; 4, labrum; 5, mandibles; 6, lacinia of the maxillæ; 7, labial palpi; 8, glossa; 9, labellum; 10, maxillary palpi; 11, mentum; 12, submentum; 13, cardo; 14, stipes. (After Herms.)

CHALASTOGASTRA (SYMPHYTA) (Suborder)

TENTHREDINOIDEA [1] (Superfamily)

Sawflies and Horntails

KEY TO FAMILIES [2]

(Figs. 636, 637, 654)

1. Front wings with free part of R_2 (second interradius) present; antennæ always with more than three segments, third segment of antennæ usually longer than all the following segments together .... **Xyelidæ** [3]
   Front wings with free part of R_2 (second interradius) always wanting; antennæ with three or more segments, third segment never so long as all the following segments together; if third segment be long, antennæ consisting of only three segments 2

2. Front wings with base of subcosta always present; pronotum transverse and scarcely emarginate behind .... **Pamphiliidæ** [4]
   Front wings with base of subcosta wanting, at most represented only by a pale indistinct line; subcosta usually represented by the free part of Sc_1, which appears like a cross vein in cell between costa and $R + M$ (subcostal); pronotum transverse but frequently so deeply emarginate behind that the mesal portion is concealed by the head 3

3. Radial cross vein (*r*) of the fore wings received by the second submarginal cell (R_5) or if it is absent or the second and third submarginal cells united (R_4 united with R_5), then the anterior tibiæ have a single apical spur 4
   Radial cross vein (*r*) of the front wings received by the third and fourth submarginal cell (cell R_4 or R_3) or wanting; anterior tibiæ always with two apical spurs 6

4. Posterior margin of the pronotum deeply arcuately emarginate 5
   Posterior margin of the pronotum straight, or nearly so .... **Cephidæ** p. 774

[1] W. H. Harrington, "Cat. of Phytophagous and Parasitic *Hymenoptera* of Vancouver Island." *Can. Ent.*, 29, pp. 16–21, 43–47, 1897.
W. M. Ashmead, "Classification of Horntails and Sawflies, or the Suborder *Phytophaga*." In 7 parts. *Can. Ent.*, 30, pp. 141–145, 177–188, 205–213, 225–232, 249–257, 280–287, 305–316, 1898. Also *Can. Ent.*, 35, p. 233, 1903; 36, pp. 63–64, 1904.
A. D. MacGillivray, "Study of the Wings of *Tenthredinoidea*." *Proc. U. S. Nat. Mus.*, 29, pp. 569–654, 1906. "The Immature Stages of the *Tenthredinoidea*." *Forty-fourth Ann. Rept. Ent. Soc. Ontario*, pp. 54–75, 1913.
S. A. Rohwer, "Notes on *Tenthredinoidea* with Descriptions of New Species." *Can. Ent.*, 40, pp. 175–180, 1908; 41, pp. 9–21, 88–92, 106–112, 145–149, 327–334, 397–399; 42, pp. 49–52, 88–93, 172–175, 215–220, 242–244; 43, pp. 119–123, 1911. "Class of the Suborder *Chalastogastra*." *Proc. Ent. Soc. Wash.*, 13, pp. 215–226, 1911. "The Genotypes of the Sawflies and Woodwasps, or the Superfamily *Tenthredinoidea*." *Tech. Ser.*, 20, pt. 2, Bur. Ent. U. S. Dept. Agr. 1911. Additions and corrections to same. *Ent. News*, 22, pp. 218–219, 1911. "Notes on Sawflies with Descriptions of New Species." *Proc. U. S. Nat. Mus.*, 43, pp. 205–251, 1913.
J. C. Bradley, "Key to Families of the Suborder *Chalastogastra*." *P. C. Jour. Ent. and Zoöl.* 5, pp. 2–4, 1913.
H. Yuasa, Classification of the Larvae of the *Tenthredinoidea*." *Ill. Biol. Mon.*, 7 No. 4, 1922. (Good Bibliography.)
[2] After A. D. MacGillivray, "Hym. of Conn." Bul. 22, pt. 3, *Conn. State Geol. and Nat. Hist. Surv.*, p. 28, 1916, and J. H. Comstock, *Introd. to Entomology*, p. 893, 1923.
[3] S. A. Rohwer, "Syn. and Desc. of Nearctic Species of Sawflies of the Genus *Xyela*," etc. *Proc. U. S. Nat. Mus.*, 45, pp. 265–281, 1913. "*Xyelidæ* and *Lydidæ*." *Can. Ent.*, 42, pp. 88–93, 220, 1910.
[4] S. A. Rohwer, "Genera of *Pamphilinæ*." *Can. Ent.*, 42, pp. 215–220, 1910.

5. Vein Sc_1 (intercosta) absent in the fore wings; the last abdominal segment bears a more or less horn-like prolongation; maxillary palpi one-segmented; labial palpi two- or three-segmented, the last segment enlarged and bearing a large sensory cup, the first segment not elongate . . . . **Siricidæ** p. 770
   Vein Sc_1 (intercosta) present; last abdominal segment without horn-like prolongation; maxillary palpi four-segmented; labial palpi three-segmented, the last without a sensory cup, the first elongate . . . . **Xiphydriidæ**

6. *Abdomen with distinct pleural sclerites; bearing the spiracles; antennæ clavate* **Cimbicidæ** p. 769
   Abdomen without separate pleural sclerites; antennæ not clavate in North American forms 7

7. *Scutellum with a distinct apical plate, the post-tergite; posterior coxæ contiguous* or nearly so; antennæ with more than three joints . . . . **Tenthridinidæ**
   Scutellum without a post-tergite; posterior coxæ often widely separate; antennæ three-jointed . . . . **Argidæ**

TENTHRIDINIDÆ. Sawflies.[1]

The sawflies are medium-sized to large four-winged insects with robust bodies, the head, thorax, and base of the abdomen about equal in width and closely jointed, and the ovipositor saw-like for inserting the eggs in plant tissues. The larvæ of many species greatly resemble caterpillars in appearance (Fig. 638), and are characterized by having one- to five-segmented antennæ, well developed true legs and six to eight pairs of prolegs. A few secrete a covering of slime and look like slugs. The majority are leaf feeders, but some are gall makers and a few are leaf miners. There are normally one or two generations a year and pupation usually occurs in a thin silken or parchment-like cocoon in the refuse on the surface of the ground where hibernation occurs. The western fauna is rich in members of this family, a great many of which still remain undescribed.

[1] E. T. Cresson, "Cat. *Hymenoptera* from Colorado. *Tenthredinidæ*." *Proc. Ent. Soc., Philad.*, 4, pp. 242–247, 1865. "Cat. of *Tenthredinidæ* of N. A. with Desc. of N. Spp." *Trans. Am. Ent. Soc.*, 8, pp. 53–66, 1880.

E. Norton, "Cat. of *Tenthredinidæ* and *Uroceridæ* of N. A." *Trans. Am. Ent. Soc.*, 1, pp. 31–84, 193–280, 1867; 2, pp. 211–242, 321–368, 1868.

A. D. MacGillivray, "*Tenthredinidæ* of Washington." *Can. Ent.*, 25, pp. 237–243, 1893.

C. L. Marlatt, "*Nematinæ* of N. A." *Tech. Ser.* 3, Div. Ent. U. S. Dept. Agr. 1896.

F. W. Konow, "*Tenthredinidæ*." *Genera Insectorum, Fasc.*, 29, 1905.

G. P. Weldon, "*Tenthredinidæ* of Colorado." *Can. Ent.*, 39, pp. 295–304, 1907.

S. A. Rohwer, "New Nematid Sawflies from Colorado." *Can. Ent.*, 40, pp. 45–50, 1908. "New Western *Tenthredinidæ*." *Jour. N. Y. Ent. Soc.*, 16, pp. 103–114, 1908. "Genus *Cryptocampus*." *Ibid.*, 17, pp. 7–25, 1909. "Western *Macrophyæ*." *Can. Ent.*, 41, pp. 327–334, 1909. "New *Blennocampinæ*." *Ibid.*, 41, pp. 397–399, 1909. "New Species of *Empira*." *Ibid.*, 42, pp. 172–175, 1910. "*Hoplocampa*." *Ibid.*, 42, pp. 242–244, 1910. "Studies in the Sawfly Genus *Hoplocampa*." *Tech. Ser.*, 20, pt. 4, Bur. Ent. U. S. Dept. Agr. 1911. "Miscl. Notes." *Can. Ent.*, 43, pp. 119–123, 1911. "Notes and Descriptions of Sawflies of the Tribe *Hemichroini*. *Proc. Ent. Soc. Wash.*, 20, pp. 161–173, 1918. "Notes and Descriptions of Sawflies." *Proc. U. S. Nat. Mus.*, 53, pp. 233–249, 1917; 57, pp. 209–231, 1920; 59, pp. 83–109, 161–167, 403–413, 1921.

S. A. Rohwer and W. Middleton, "N. A. Sawflies of the Subfamily *Cladiinæ* and Notes on Habits and Descriptions of Larvæ." *Proc. U. S. Nat. Mus.*, 60, No. 2396, Art. 1, pp. 1–37, 1922.

W. Middleton, "Structural Studies of Larvæ and Adults." *Proc. U. S. Nat. Mus.*, 48, pp. 497–501, 1915. *Proc. Ent. Soc. Wash.*, 23, pp. 139–144, 173–192, 1921. "Descriptions of Some N. A. Sawfly Larvæ." *Proc. U. S. Nat. Mus.*, 61, No. 2442, Art. 21, 1922.

Control measures consist usually in the application of poison sprays in the form of 3 pounds of powdered arsenate of lead to 100 gallons of water.

FIG. 638.—Larvæ of sawflies in natural feeding attitudes on willow leaf. (Photo by S. B. Doten.)

The timothy sawfly, *Dolerus collaris* Say, is shining black with portions of the thorax orange. The slender cylindrical larvæ are 15–25 mm. long, greenish, and feed on timothy in Colorado.

The dock falseworm or dock sawfly, *Ametastegia glabrata* (Fallén) (*Tenthredo, Taxonus, T. nigrisoma* Norton),[1] is blue-black with reddish legs and 10–12 mm. long. The larvæ are olive or bluish green with conspicuous white body tubercles, seven pairs of prolegs, and are 14–16 mm. long. They normally feed on docks, sorrels, and knotweeds. There are four broods. The larvæ of the last brood hibernate usually in the dead stems of the host plants, but frequently burrow into the fruit of apples to pass the winter and do considerable damage in certain sections of Washington and British Columbia. The species ranges throughout the northern parts of the United States and in Canada. It also occurs in Europe.

[1] E. J. Newcomer, Bul. 265, *Prof. Paper*, Bur. Ent. U. S. Dept. Agr. 1916. This species is listed as a synonym of *A. fulvipes* A. Costa by S. A. Rohwer, *Tech. Ser.*, **20**, pt. 2, Bur. Ent. U. S. Dept. Agr., p. 73, 1911.
S. A. Rohwer, *Proc. Ent. Soc. Wash.*, 17, pp. 198–199, 1915.

The violet sawfly, *Emphytina canadensis* (Kirby) (*Emphytus*),[1] is black with yellowish white markings on the legs and 5–7 mm. long. The larvæ are dark olive green with black head, transparent prolegs, and pale areas around the spiracles. The adults appear in early spring and insert the eggs from above to just beneath the lower epidermis of the tender leaves causing a blister on the under surfaces. They are often serious pests to wild and cultivated violets and pansies. There are several broods annually and the larvæ are most evident in August and September in the San Francisco Bay region, California. The species occurs generally in boreal North America. The larvæ are controlled by lightly dusting with arsenate of lead or by spraying with 1 part of 40 per cent nicotine sulfate to 600 parts of water.

The fern sawfly, *Strongylogaster pacificus* MacGillivray, is black with yellow markings, the head and sides of thorax clothed with dense silky pile, and 6–8 mm. long. The legs of the female are partly white and those of the male wholly white. The larvæ are first shining transparent green with white subdorsal line and black spiracles. They later become reddish and attain a length of 20 mm. They are most common in June, feed on the common brake, *Pteris aquilina* Linn., and hibernate in the dead stems. The species is recorded in Oregon and Washington and probably occurs in adjacent States.

The raspberry sawfly, *Monophadnoides rubi* (Harris) (*Selandria, Hoplocampa, Monophadnus*), is black with yellow and reddish markings and 5.5

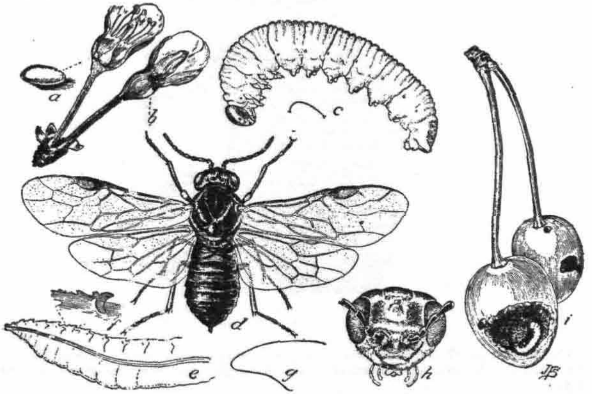


FIG. 639.—The cherry fruit sawfly, *Hoplocampa cookei* (Clarke). *a*, egg; *b*, position of egg in the blossom; *c*, larva; *d*, adult female; *e*, saw of the female's ovipositor; *f*, serrations on saw; *g*, sheath of the saw; *h*, head of adult, front view; *i*, infested cherries showing larva inside and exit and entrance holes. *a, c, d, e, f, g,* and *h*, greatly enlarged; *b* and *i*, slightly enlarged. (After Foster, U. S. Dept. Agr.)

mm. long. The larvæ are pale green, with white spiny body tubercles, and attain a length of 16 mm. The adults appear in the spring about blossoming time and insert the eggs in the leaf tissues. The larvæ feed on the undersides of the leaves and eat out numerous small holes. Raspberries and many species of berries are attacked, loganberries being most

[1] F. H. Chittenden, Bul. 27 n. ser. Div. Ent. U. S. Dept. Agr., p. 26, 1901.

commonly and seriously defoliated in parts of Oregon.[1] The species ranges throughout boreal North America, and is most often met with along the Pacific Coast in the west.

The cherry fruit sawfly, *Hoplocampa cookei* (Clarke) (*Dolerus, Hoplocampa californica* Rohwer)[2] (Fig. 639), is black, with a portion of the head, the antennæ, and legs yellow or reddish brown, and measures 3–5 mm. in length. The adults appear in the early spring and lay kidney-shaped, shining white eggs singly in the sepals or under the calyx cup of the developing blossoms about the middle of March. The eggs hatch in three or four

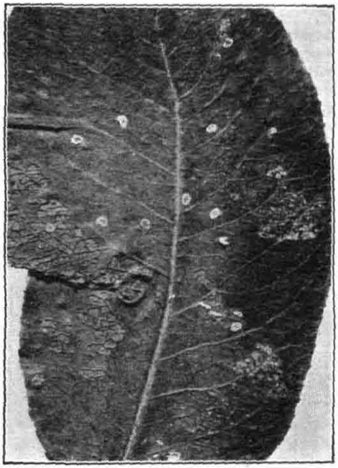


FIG. 640.—Eggs and work of the larvæ of the pear slug, *Eriocampoides limacina* Retzius, on pear leaf.

days at about the time the petals fall and the young larva enters the small fruit and eats into the undeveloped kernel. From one to several fruits are thus destroyed before maturity is reached. Full grown larvæ are crescent shaped, clear white with brown head, distinctly segmented and wrinkled, with seven pairs of prolegs, and measure 4–5 mm. They leave the fruit through a round hole in the side and pupate within a small silken cocoon in the soil where hibernation occurs. There is but a single brood

[1] A. L. Lovett, *Third Crop Pest and Hort. Rept.* 1915–1920, Ore. Agr. Exp. Sta., p. 128, 1921.

[2] W. T. Clarke, *Can. Ent.*, 38, p. 351, 1906. Orig. desc.
S. W. Foster, Bul. 116, pt. 3, Bur. Ent. U. S. Dept. Agr. 1913.
E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed., p. 357, 1915.
W. P. Duruz, *Mthly. Bul.*, Cal. State Dept. Agr., 11, p. 392, 1922.

annually. The fruit of wild and cultivated cherries and plums are commonly attacked. Of the domesticated plums, the varieties Climax, Diamond, and Grand Duke, particularly in the Vacaville section of California, are most seriously injured. Prunes are occasionally infested in southern Oregon. The sawfly ranges from central California northward through Oregon into Washington, being reported at Everett in the latter State in 1922 by A. L. Melander. Infested fruits turn yellow and drop off prematurely. The presence of the exit hole and the eaten-out kernel at once distinguish the work of this insect. Two undetermined parasites are recorded by S. W. Foster in California. W. P. Duruz secured excellent control on plums at Vacaville, California, by using a 1–12 commercial lime-sulfur solution to which is added ½ pint of 40 per cent nictotine sulfate to 100 gallons of the spray; as well as with 2 gallons of miscible oil and ½ pint of 40 per cent nicotine sulfate to 100 gallons of water applied as the blossoms were opening.

The pear slug, *Eriocampoides limacina* Retzius [*Caliora cerasi* (Linn.)] (Figs. 640–642), is shining black in the adult stage with infuscated wings,

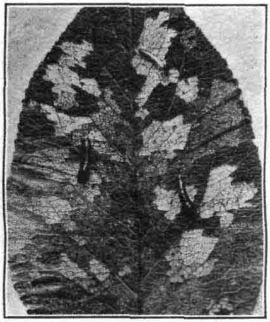


FIG. 641.—Larvæ of the pear slug, *Eriocampoides limacina* Retzius, and work on pear leaf.

and 8 mm. long. The adults appear in the spring and again in late summer, and insert the small oval flattened eggs under the epidermis of the upper sides of the leaves. The eggs hatch in one or two weeks and the minute larvæ begin feeding on the upper surfaces of the leaves. They are various shades of olive green due to a covering of slime-like material which gives them the appearance of slugs. The prothoracic area is much larger than the rest of the body and the length when mature averages 10–13 mm. Freshly molted individuals are yellow until the dark slime is secreted. The larvæ feed on the epidermis of the leaves and may remove all excepting a fine network of veins. In cases of severe infestations, large orchards are often almost entirely defoliated. There are two broods in the west, the larvæ of the first appearing in April and May in California, and in June

and July in Oregon; and those of the second in July and August in California, and August and September in Oregon. Both broods, however, may continue later than indicated. The second brood is the most numerous and destructive. Females of the first brood are largely parthenogenetic and produce a large second brood in the fall. Hibernation occurs within cells in the soil and the emergence of the spring brood is drawn out over a considerable period of time, while the last brood emerges nearly together. Certain varieties of cherries and pears are preferred hosts, but buttonbrush, hawthorn, Juneberry, mountain ash, plum, and quince are also infested. The species occurs in Europe and throughout North America, and is known in every Western State. Although this insect regularly does large damages to the orchards throughout our country, it is one of the easiest pests to control. Dusting with ashes, lime, or road dust readily kills the larvæ. The writer has secured best results in orchards by dusting with a very

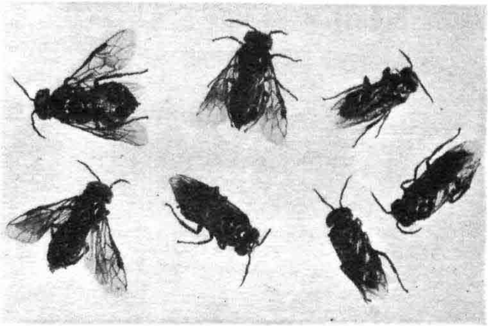


FIG. 642.—Adults of the pear slug, *Eriocampoides limacina* Retzius.

weak nicodust as recommended for the walnut aphis. Washing the trees with water is an excellent remedy for dooryard trees.

The California pear sawfly, *Diphadnus californicus* (Marlatt) (*Gymnonychus*)[1] (Figs. 643, 644), is black with yellow markings on the prothorax and 5–6 mm. long. The eggs are inserted into the leaves. The larvæ are bright green to match the color of the leaves on which they feed and are 13 mm. long when mature. They have a characteristic habit of resting on the edges of the leaves in circular or oval holes eaten into the margins or the middle. Pear is the only known host plant. The larvæ are most abundant in April and May. They hibernate in thin brown cocoons in the soil. There is but one brood a year. The species occurs in the northern half of California, Oregon, and Washington, and is recorded also in Connecticut and New York. Arsenate of lead as recommended for the codling

[1] R. L. Nougaret, W. M. Davidson and E. J. Newcomer, Bul. 438, Bur. Ent. U. S. Dept. Agr. 1916.

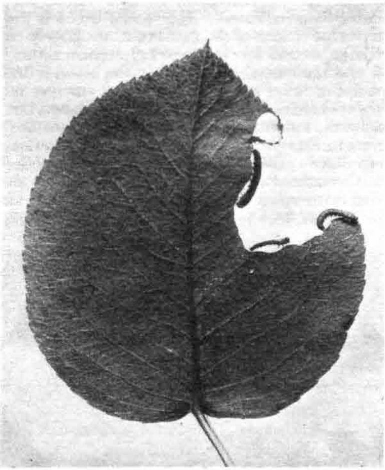


FIG. 643.—Larvæ of the California pear sawfly, *Diphadnus californicus* (Marlatt) and characteristic work on pear leaf.

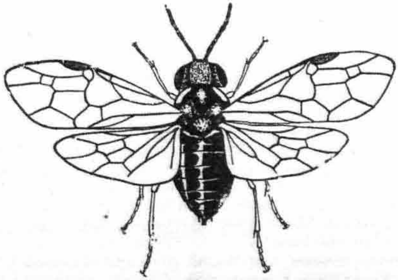


FIG. 644.—Adult of the California pear sawfly, *Diphadnus californica* (Marlatt). (Redrawn from Marlatt.)

moth also controls this sawfly. **The gooseberry sawfly,** *Diphadnus appendiculatus* (Hartig) (*Gymnonychus*, *Pristophora grossularia* Walsh),[1] is shining black with yellowish legs and yellow and brown markings, and 5 mm. long. The eggs are inserted singly under the epidermis in the edges of the leaves. The larvæ are green with white venter and 13 mm. long. They feed on the leaves of wild and cultivated gooseberries and currants, and occur in the Northeastern States and in Colorado and Idaho in the west. Two generations are reported in Colorado and one in Idaho. Two pounds of powdered arsenate of lead to 100 gallons of water gives control.

The willow leaf gall sawfly, *Pontania californica* Marlatt (Fig. 645), is shining black with rufous markings and 4.5 mm. long. The small white larvæ live in smooth red

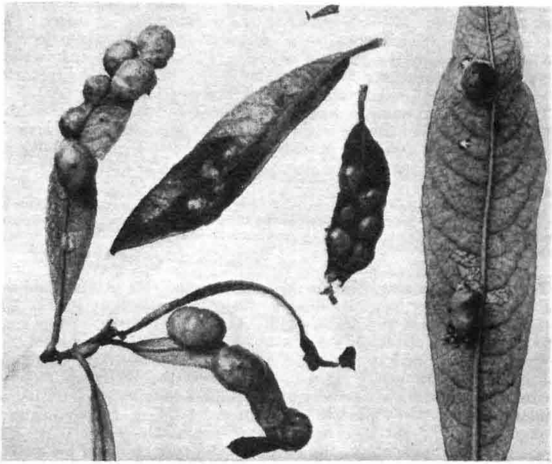


FIG. 645.—Galls of the willow leaf gall sawfly, *Pontania californica* Marlatt, on willow leaves.

and green subspherical galls, 8–12 mm. long, which occur equally on both surfaces of the leaves of willows in California, being very common and abundant in the San Francisco Bay region. *Pontania parva* (Cresson) is black with yellow appendages and 3.5–4 mm. long. The larvæ form oval galls 8 x 6 mm., mostly projecting on the undersides of the leaves, the lower area being tuberculate and rosy. The species occurs on willow in Arizona, California, Nevada, Oregon, Washington, and Montana. **The resin colored sawfly,** *P. resinicola* Marlatt, is amber yellow with darker markings on the dorsum and 5.5 mm. long. The larvæ form irregular oval galls on both sides of the leaves in a mass or in a row on each side of the midrib. The species infests willow in various parts of California. *Pontania bozemani* Cooley is often destructive to the leaves of poplar in Montana.

[1] C. P. Gillette and G. M. List, Bul. 210, Colo. Agr. Exp. Sta. 1915.

The imported currant worm, *Pteronidea ribesi* (Scopoli) (*Nematus, Pteronus*), is robust, brownish black and pale yellow, and 7.5 mm. long in the adult stage. The adults appear from May to July and attach the smooth, elongate whitish eggs which are 1 mm. long, end to end in rows to the larger veins of the undersides of the leaves of wild and cultivated currants and gooseberries. The eggs hatch in 7–10 days and the larvæ feed on the leaves, often doing considerable damage. Immature forms may have dark head and black body spots, but when full grown they are of a uniform green and measure 20 mm. in length. Pupation occurs in a brown silken cocoon on the hosts or among the leaves and rubbish on the ground. Two or three broods appear annually. This European insect is very common in the Eastern States and has proven injurious to currants and gooseberries in Colorado and Idaho in the west. Control measures consist in spraying with 2 pounds of powdered arsenate of lead to 100 gallons of water. *Pteronidea thoracica* (Harrington) has a greenish white larva which feeds on the lower surfaces of the leaves of service berry or shad bush and on choke cherry in Oregon and Washington. The larvæ of *P. occidentalis* Marlatt (*Pteronus*) feed on the leaves of willow throughout California.

The cherry stem borer, *Simplemphytus pacificus* MacGillivray,[1] is black with portions of the legs pale or rufous, and 7–9 mm. long. The larvæ are reported as boring down the pruning stubs of cherry trees and doing but little damage in Oregon.

Cryptocampus macgillivray Rohwer and *C. bebbianæ* Rohwer have small white larvæ 5 mm. long which produce gradual (in the first species) and abrupt (in the second species) twig enlargements on willows in Colorado and probably in other Western States.

The bristly rose slug, *Cladius isomerus* Norton[2] (Fig. 646), is polished black and 6–8 mm. long in the adult stage. The adults appear in April and May and insert the white slightly flattened ovoid eggs from above into slits cut into the midribs of the leaves. The larvæ are whitish green clothed with hair and 16 mm. long when mature. They first skeletonize and later eat holes into or entirely devour the leaves of roses. Pupation occurs within a whitish or brownish cocoon in leaves and refuse during the summer, and in the ground during winter. A life cycle requires about 30 days and in the east there are as many as six generations a year. This species occurs commonly in the east and was first observed on roses at Alameda, California, by the writer in October, 1921. It is quite generally distributed in the San Francisco Bay region, but has so far caused little trouble. It is controlled by spraying with 2 pounds of powdered arsenate of lead to 100 gallons of water, or by dusting with powdered arsenate of lead.

The yellow pine sawfly, *Diprion gillettei* (MacGillivray) (*Lophyrus*), is black with yellow appendages and 6.5 mm. long. The larvæ feed on the needles of yellow pine in Colorado.

[1] H. F. Wilson, *Second Bien. Crop. Pest and Hort. Rept.* 1913–14, Ore. Agr. Exp. Sta., p. 121, 1915.

[2] W. Middleton, *Farmers' Bul.* 1252, U. S. Dept. Agr. 1922.

The cedar cone sawfly, *Augomonoctenus libocedri* Rohwer, is shining blue black with the first five abdominal segments rufous, and 5–9 mm. long. The larvæ feed in the cones of incense cedar in Oregon.

The globe mallow sawfly, *Nematoneura malvacearum* Cockerell,[1] is black with the thorax and abdomen red and 8.25 mm. in length. The larvæ are shiny yellowish pink with black body tubercles, the last segment black above, and 14 mm. long. They

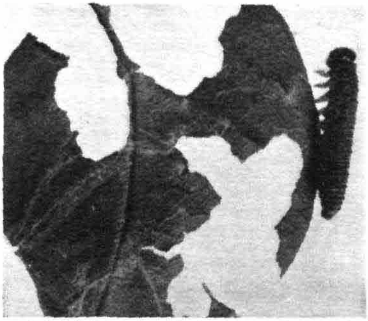


FIG. 646.—Larva of the bristly rose slug, *Cladius isomerus* Norton, and work on rose leaf.

feed on the native globe mallow in northern Mexico and New Mexico, but do not appear to attack cultivated hollyhocks.

CIMBICIDÆ. Cimbicid Sawflies.

The elm sawfly, *Cimbex americana* Leach, is a common species throughout eastern and middle boreal North America and ranges westward into Colorado and British Columbia. A number of varieties are recognized in the east. The adults are large, steel blue and black with three or four oval yellow spots on each side of the body, short knobbed antennæ, smoky wings, and measure 18–25 mm. They appear in the spring and insert the transparent oval flattened eggs in the leaves. The larvæ are naked, wrinkled, pale yellow with a median dorsal black stripe, eight pairs of prolegs, usually coiled, and measure 20–50 mm. in length. They feed on the leaves of alder, basswood, elm, linden, maple, poplar, and willow. Hibernation occurs in the larval stage within oval brown cocoons in rubbish at the bases of the trees, where pupation takes place early in the spring. **The Pacific sawfly,** *Cimbex pacifica* Cresson, is brownish red, 24 mm. long, and occurs on willow in Oregon and Washington. *C. rubida* Cresson is ferruginous with some black markings. The front margins of the basal abdominal segments are black and the wings metallic blue and smoky brown. The length is 18–20 mm. It occurs on willows in the Sierras of California and Nevada, and in the coastal region of Central California. *Trichiosoma languinosa* Norton is velvety or shining bluish black with dense pale yellow pile on the head, thorax, and base of the abdomen, and resembles somewhat a bumblebee. The antennæ are short and knobbed, the wings are smoky brown, and the length is 9–11 mm. The larvæ feed on willows in the Sierras of California and Nevada. *Abia americana* (Cresson) (*Zarea*) is robust black and metallic brassy or grayish green, the head and thorax clothed with fine black pile, and the abdomen with short silky pubescence. The antennæ are short, the legs pale, the wings spotted brown, and the length of the body averages 10 mm. This species also occurs in the Sierras of California and Nevada and along the coast in Central California.

[1] *Insect Life*, 7, pp. 251–253, 1894.

SIRICIDÆ.[1] Horntails, Wood Borers, Wood Wasps.

This family comprises medium to large cylindrical, closely joined insects with the head, thorax, and abdomen of equal width; long filiform antennæ; two pairs of well developed wings; and the mesothorax with a transverse line in front of the scutellum. The females are provided with long ovipositors and sheaths. The colors are mostly black or metallic dark blue, or combinations of black, red, and yellow. The eggs are deposited in the

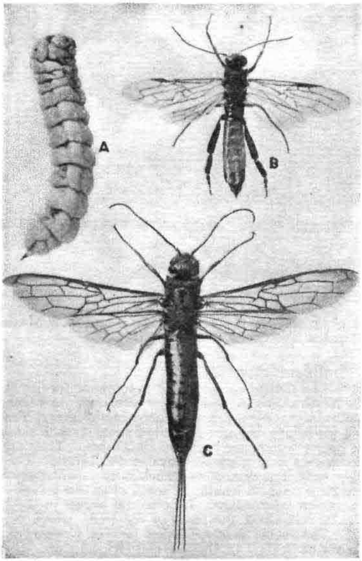


FIG. 647.—The western horntail, *Sirex areolatus* (Cresson). A, larva; B, adult male; C, adult female.

bark or wood of many kinds of shrubs and trees. The larvæ are usually cylindrical, "S"-shaped, yellowish white, and with a small spine at the posterior end. They are wood borers, and are often destructive to coniferous trees. Control measures consist in burning dead infested trees during the fall, winter, and early spring.

[1] F. W. Konow, "*Hymenoptera. Siricidæ.*" *Genera Insectorum. Fasc.*, 28, 1902.
J. C. Bradley, "The *Siricidæ* of N. A." *P. C. Jour. Ent. and Zoöl.*, V, pp. 1–30, 1913. Complete.

The western horntail, *Sirex areolatus* (Cresson) (*Urocerus, Sirex apicalis* Kirby) (Figs. 647, 648), is a large dark metallic blue species with smoky wings, 24–35 mm. long, and the ovipositor, extending 10–15 mm. beyond the tip of the abdomen. The males are much smaller and have the abdominal segments 3–7, and sometimes the front tibiæ and tarsi, rufous, and have been known as *Sirex apicalis* Kirby. The larvæ are yellowish white and 25–35 mm. long. They burrow into the sapwood and heartwood of dead Monterey cypress and other cypress trees, cedar, redwood, pine, Douglas fir, and related trees. Cured redwood lumber is frequently attacked in the yards of Humboldt and Mendocino Counties in California. Adults were found ovipositing in dead Monterey cypress at Berkeley,

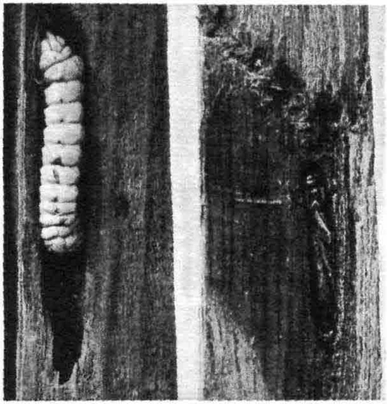


FIG. 648.—The western horntail, *Sirex areolatus* (Cresson). Larva and pupa within galleries in cured redwood.

California, November 22, 1922, by S. E. Flanders. The species occurs in New Mexico, Arizona, Colorado, California, Oregon, Washington, and British Columbia. The race *areolatus* (Cresson) inhabits all of the above described territory, excepting British Columbia where the race *cæruleus* (Cresson) (*Urocerus cæruleus* Cress.) occurs.

Behrens' horntail, *Sirex behrensi* (Cresson) (*Urocerus*) (Fig. 649, A, B), is metallic or opaque blue-black, the tarsi, portions of the legs, and antennæ, and all excepting the two basal abdominal segments reddish, the middle and tips of the wings are clouded, and the length is 30–35 mm. It was taken ovipositing in dead Monterey cypress at Berkeley, California, November 22, 1922, by S. E. Flanders. The larvæ must attack other conifers, inasmuch as the species ranges in much of California and Nevada. **The California horntail,** *Sirex californicus* (Ashmead) (*Paururus*), is uniformly dark

blue with hyaline wings and 23 mm. long. It occurs in California, Oregon, Washington, and British Columbia and has also been reported from New Mexico.

The polished horntail, *Sirex juvencus* (Linn.) race *cyaneus* (Fabr.) (*Sirex cyaneus* Fabr., *Urocerus*), is dark metallic blue, the legs, except the coxæ, are red or yellow, the wings hyaline or slightly infuscated on the outer margins, and the length 20 mm. The larvæ attack many kinds of coniferous trees including pine, fir, spruce, and Douglas

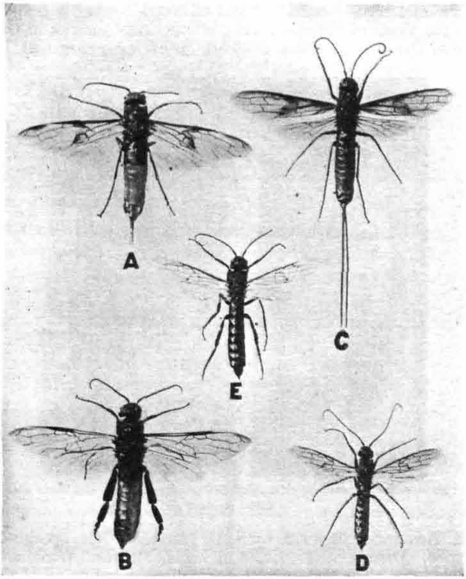


FIG. 649.—Western horntails. A, female and B, male of Behren's horntail, *Sirex behrensi* (Cresson); C, female and D, male of Morrison's horntail, *Xeris morrisoni* (Cresson); E, male of *Xeris spectrum* (Linn.).

fir. The species ranges from the New England States and New Brunswick, west to British Columbia and along the Rocky Mountains, south into New Mexico and along the Pacific Coast into California. *Sirex obesus* Bradley is metallic blue-black throughout with dark violaceous wings and the body 28 mm. long. It occurs in Arizona and California.

Urocerus albicornis (Fabricius) (*Sirex*, *Urocerus abdominalis* Harris, male) is entirely blue-black or black, the middle of antennæ, cheeks, bases of tibiæ and tarsi, and sometimes lateral spots on the abdomen, white; the wings are smoky. The males have the abdominal segments 3–6 yellow, and the wings hyaline. This species occurs throughout boreal North America and is known in Wyoming, Idaho, Washington, and British

Columbia, Oregon, California, Arizona, and New Mexico in the west. *U. californicus* (Norton) (*U. albicornis* var. *californicus* Norton, *U. fulvus* Cress., male) (Fig. 650, A) is a large dull and shining black species with the antennæ, cheeks, bases of tibiæ and tarsi, and apical lateral spot on the abdomen yellow, the wings golden yellow, and the body 28–35 mm. long to the tip of the cornus, in the female. In the male the thorax is reddish or brownish, the antennæ, legs, and abdomen yellowish red, and the wings yellow. The larvæ infest pines, firs, and Douglas fir in the high mountains of New Mexico, Arizona, California, Nevada, Utah, Colorado, Idaho, Oregon, Washington, and British Columbia. *U. flavicornis* (Fabricius) (*Sirex bizonatus* Stephens, *Urocerus*

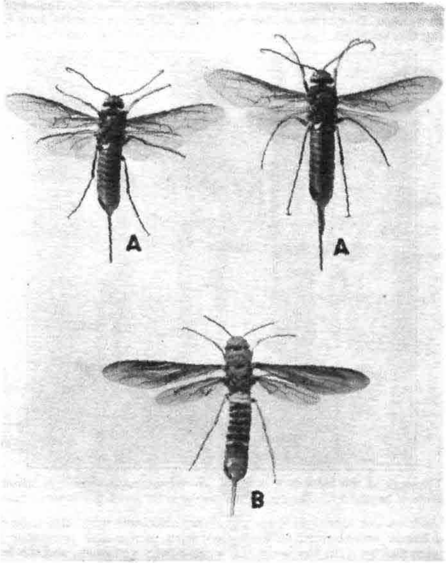


FIG. 650.—Western horntails. A, females of the California horntail, *Urocerus californicus* (Norton); B, female of the pigeon tremex, *Tremex columba* (Linn.).

riparius MacG., male) is black with the antennæ, tibiæ, tarsi, second, seventh, eighth, and often the first abdominal segments yellow or reddish, the wings subhyaline or yellow towards the base, the length 22–33 mm. The males have the abdominal segments 3–6 yellow, and hyaline wings. This species breeds in pine, fir, Douglas fir and other coniferous trees, and ranges throughout boreal North America. In the west it occurs in the high mountains of New Mexico, Colorado, Wyoming, Montana, Utah, Idaho, Arizona, California, Nevada, Oregon, Washington, British Columbia, and Alaska. It also occurs in Mexico.

Morrison's horntail, *Xeris morrisoni* (Cresson) (*Urocerus*, *U. tarsalis* Cress., *U. indecisus* MacGillivray) (Fig. 649, C, D), has the head and thorax black, the cheeks white or yellow, the antennæ and legs entirely black or dark reddish brown, or partly

black and reddish, the abdomen reddish in the female and reddish or blackish in the male, the ovipositor black and as long as the body, and the wings smoky. The length varies from 12–25 mm. This species occurs in the high coniferous forests of Colorado, Utah, Nevada, California, Oregon, Washington, and British Columbia. The author has taken it ovipositing in living and dead white fir and lodgepole pine. It also probably attacks many other coniferous trees. *Xeris spectrum* (Linn.) race *caudata* (Cresson) (*Urocerus caudatus* Cress.) (Fig. 649, E), is black, the legs reddish yellow or partly black, a white spot on each side of the temples of the males, and the ovipositor of the females longer than the body, which is 25–35 mm. long. It occurs in the Rocky Mountains from Colorado north to Alaska and in the high mountains south along the Pacific Coast through British Columbia, Washington, and Oregon into California, Nevada, and Utah.

The pigeon tremex, *Tremex columba* (Linn.) (Fig. 650, B), is a large black species with the head and thorax often reddish and black, cheeks yellow, antennæ yellow at the

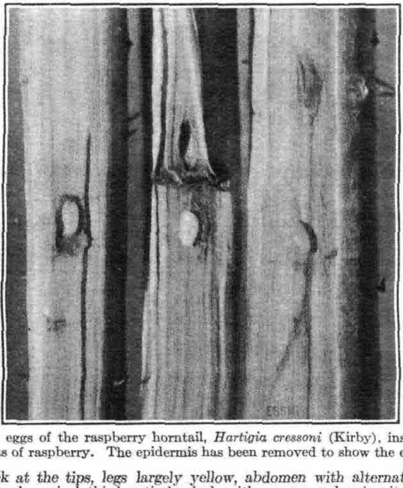


FIG. 651.—The eggs of the raspberry horntail, *Hartigia cressoni* (Kirby), inserted into the tender shoots of raspberry. The epidermis has been removed to show the eggs *in situ*.

bases and black at the tips, legs largely yellow, abdomen with alternate yellow and black dorsal bands, apical third entirely dark with cornus and ovipositor yellow, the ovipositor much shorter than the body, the wings smoky yellowish, and the length 25–30 mm. This species attacks various coniferous trees throughout North America. The race *sericeus* (Say) occurs in the Southeastern States and ranges west into Colorado and Utah, and the race *aureus* Bradley occurs in Colorado, New Mexico, Arizona, and California.

CEPHIDÆ.[1]

The western grass-stem sawfly, *Cephus cinctus* Norton (*C. occidentalis* Riley and Marlatt, *C. grænicheri* Ashmead),[2] is 8–11 mm. long, black spotted

[1] E. T. Cresson, "American *Cephidæ*. *Trans. Am. Ent. Soc.*, 8, p. 33, 1880.
W. Middleton, "Notes on the Larvæ of Some *Cephidæ*." *Proc. Ent. Soc. Wash.*, 19, pp. 174–179, 1917.

[2] C. V. Riley and C. L. Marlatt, *Insect Life*, 4, pp. 177–179, 1891.
F. M. Webster, Circ. 117, Bur. Ent. U. S. Dept. Agr. 1910.
S. A. Rohwer. *Proc. Ent. Soc. Wash.*, 19, pp. 139–140, 1917.

and banded with yellow markings on the body, and the greater part of the stigma and femora also yellow. The larvæ are whitish, cylindrical, somewhat enlarged at the thorax, antennæ 5-jointed, and the body 11 mm. long. The eggs are laid on the host plants in May and June and the larvæ mine the stems of brome grass, wild rye, quack grass, wheat grass, other wild grasses, timothy, wheat, and barley, in New Mexico, Colorado, Utah, Wyoming, Montana, Oregon, California, Nevada, Arizona, and probably other Western States. Within the stems near the surface of the ground they enlarge the burrows and hibernate. At the enlargements the stems are weakened and break. Within them pupation occurs in a silken cocoon in

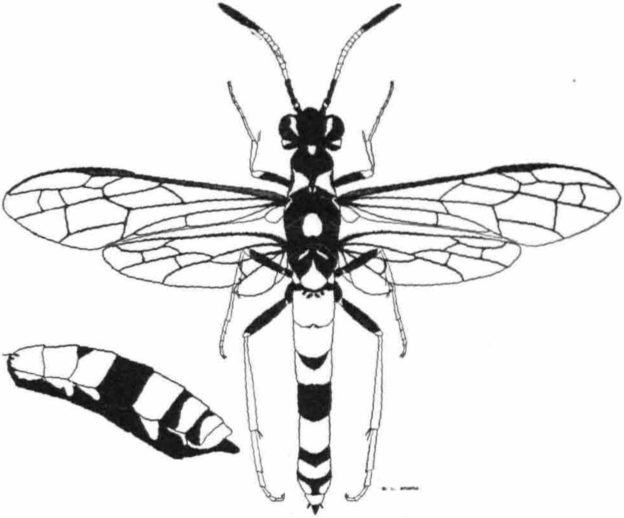


FIG. 652.—Adult female of the raspberry horntail, *Hartigia cressoni* (Kirby).

the spring. There is but a single brood annually. Burning the stubble in the fall, deep plowing, and crop rotation afford control when necessary.

The raspberry horntail, *Hartigia cressoni* (Kirby) (*Cephus abdominalis* Cresson)[1] (Figs. 651–653), varies from 12–15 mm. in length and is slender in form. The females are marked bright yellow and black, while the males are mostly black as illustrated. They appear in April and May and the females insert the oblong pearly white eggs which have a curved point at

[1] E. O. Essig. *Mthly. Bul.*, Cal. State Com. Hort., 1, pp. 889–901, 1912. Also *Inj. and Ben. Ins. Cal.*, 2d ed., pp. 353–355, 1915.

one end, just under the epidermis of the tender tips of the host plants. The presence of the eggs is indicated by the discolored incisions and by a pronounced swelling. The eggs hatch in a few days into very small larvæ which spirally girdle the tips causing them to wilt and die. Mature larvæ are white with dark heads and anal prong, cylindrical, somewhat "S"-shaped, with three pairs of legs and without prolegs, and attain a length of 22–25 mm. They work in the pith of the canes and downward often into the larger roots. Pupation occurs within a silk lined cell in the burrows and the adults emerge through a round hole from the sides of the canes. The winter is spent as larvæ within the burrows and pupation occurs in the spring. One and possibly two broods occur each year. The chief damage is to the young vigorous shoots of blackberries, loganberries, raspberries,

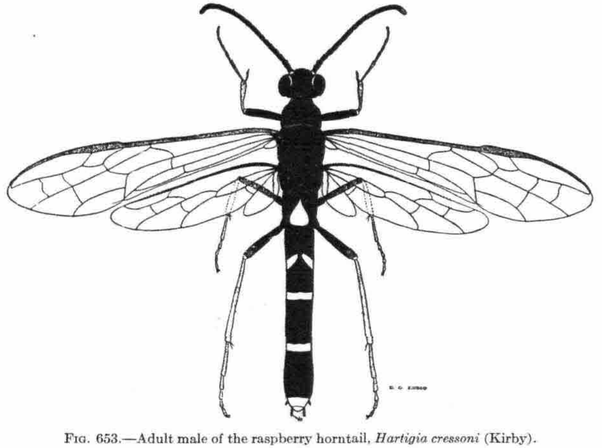


FIG. 653.—Adult male of the raspberry horntail, *Hartigia cressoni* (Kirby).

and roses. Both wild and cultivated plants are freely and often seriously infested, particularly in the western foothills of the Sierra Nevada Mountains of California. The species also occurs in Nevada. Several undetermined parasites have been reared from the pupæ. Control measures consist in cutting the infested shoots just below the point of attack in the spring and in pruning out the infested canes during the winter.

The cedar horntail, *Syntexis libocedri* Rohwer, is black with greenish white markings on the sides of the thorax, reddish legs beyond the coxæ, and 8 mm. long. The larvæ bore the outer wood of incense cedar in California.

Idiogastra (Suborder)

Parasitic Woodwasps

ORYSSIDÆ.[1] The Parasitic Woodwasps.

The western oryssus, *Oryssus occidentalis* (Cresson) (*O. abietis* Rohwer), is the best known western representative of this family. The adults are black with the six posterior abdominal segments shining ferruginous, and 8-14 mm. in length. The larvæ are white, somewhat flattened, and with the caudal end slightly upturned. The females oviposit into wood of many kinds of trees. It was generally supposed that the larvæ were wood-borers until they were recently proved to be parasitic on the larvæ of wood-boring beetles by H. E. Burke.[2] The larvæ of this woodwasp have been found by Burke to be parasitic on *Buprestis confluenta* Say, on aspen in California, and on *B. læviventris* (Lec.) and *Chrysophana placida* (Lec.), on yellow pine in California. The distribution includes Colorado, Nevada, California, Oregon, Washington, and British Columbia. *Oryssus hopkinsi* Rohwer has been reared from the mine of the larvæ of a cerambycid beetle in dead areas of living Douglas fir in Washington. Many other species are reported from the west without host records.

Clistogastra (Apocrita) (Suborder)

Key to Superfamilies [3]

1. First abdominal segment [4] (sometimes also the second) forming a lens-shaped scale or knot (petiole), strongly differentiated from the remaining abdominal segments (gaster). (Ants.) .... **Formicoidea** p. 853
   Abdominal segments not strongly differentiated as petiole and gaster 2

2. Mesothorax anteriorly without the free prepectus 3
   Mesothorax anteriorly with a prepectus; usually winged, with venation reduced to a minimum; usually less than 3 mm. in length and metallic. (Chalcid Flies.) .... **Chalcidoidea.** p. 813

3. Tegulæ present, wings usually well developed, sometimes vestigial or lost 4
   Tegulæ wanting, wings entirely absent, habitus respectively as in winged forms .. 8

4. Pronotum with its hind angles or tubercles tangent to a vertical line drawn tangent to anterior edge of tegulæ, touching or underlying tegulæ 5
   Pronotum with its hind angles or tubercles always distinctly remote from tegulæ. 11

[1] J. C. Bradley, "N. A. *Oryssidæ.*" *Trans. Am. Ent. Soc.*, 27, pp. 317-330, 1901.
S. A. Rohwer, "Studies in the Woodwaps Superfamily *Oryssoidea*, with Descriptions of New Species." *Proc. U. S. Nat. Mus.*, 43, pp. 141-158, 1913.
S. A. Rohwer and R. A. Cushman, "*Idiogastra*, A New Suborder of *Hymenoptera* with Notes on the Immature Stages of *Oryssus*." *Proc. Ent. Soc. Wash.*, 19, pp. 89-95, 1917.

[2] *Proc. Ent. Soc. Wash.*, 19, pp. 87-89, 1917.

[3] Published with kind permission of W. E. Britton from *Hymenoptera* of Connecticut, Bul. 22, pt. 3, p. 22, *Conn. State Geol. and Nat. Hist. Surv.*, 1916.

[4] In all the *Hymenoptera* the segment which is morphologically the first abdominal segment (propodeum) is intimately fused with the thorax, of which it seems to be a part. In this work the general usage of descriptive writers is followed, and the segment which is apparently the first abdominal segment, though morphologically the second, is uniformly called the first abdominal segment.
J. H. Comstock adds the superfamily *Evanioidea* and omits *Formicoidea*, *Apoidea*, and *Chrysidoidea* as given in this table.

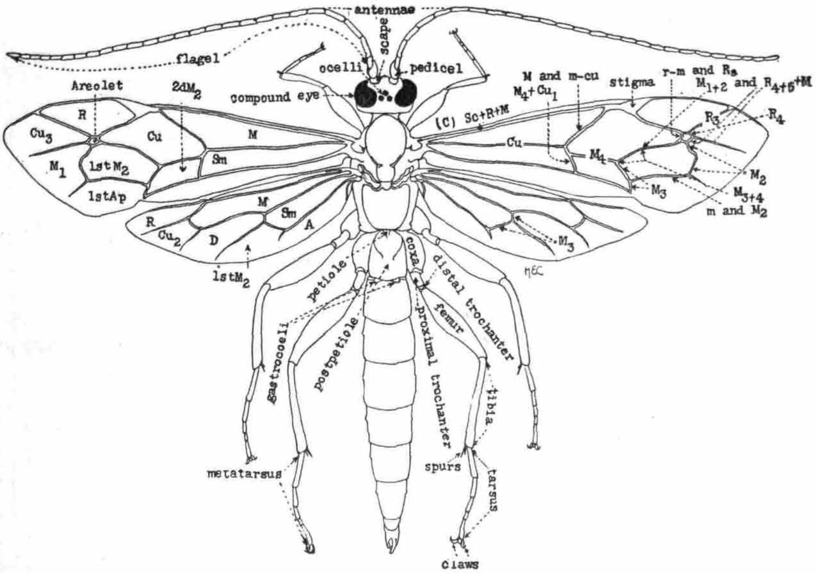


FIG. 654.—Ichneumon parasite, *Itoplectis behrensi* (Cresson), of the California oak moth, *Phyganidia californica* Pack. Principal parts are labeled. The veins are as follows: (C) + Sc + R + M (costal and subcostal); Cu (median); M and m-cu (basal); M_2 (2d recurrent); M_3 (2d and 3d abscissa of discoidal); M_4 (1st abscissa of discoidal); $M_3 + 4$ (1st recurrent); m and M_2 (subdiscoidal); $M_1 + 2$ and $R_4 + 5 + M$ (cubital); R_3 (marginal or radius); r-m and Rs (1st transverse cubital); R_4 (2d transverse cubital). *Cells:* A (*Anal*), *areolet* (*2d cubital*); *1st Ap* (*1st apical*); *Cu* (*1st cubital*); *Cu_2* (*2d cubital*); Cu_3 (3d cubital or submarginal); D (discoidal); M (median); M_1 (2d apical); 1st M_2 (3d discoidal); 2d M_2 (2d discoidal); R (radial); Sm (submarginal).

5. Body not flea-like 6
Body flea-like; trochanters usually composed of a single joint; wings usually with a characteristic venation as shown in Fig. 668, C. (Gallflies.) **Cynipoidea** p. 800

6. Wings with at least basal, median and subcostal veins present, usually with venation well developed as shown in Fig. 654 7
Wings usually without veins or with only subcosta and part of radius present, as in figure of *Pelecinus* in Packard's Guide. (Pointed-tailed Wasps) **(Serphoidea) Proctotrupoidea** p. 851

7. Trochanters composed of two joints. (Ichneumon Flies.) . . . . **Ichneumonoidea**
Trochanters composed of one joint 13

8. Body not flea-like, not compressed 9
Body flea-like, compressed as in winged forms. (Gallflies.) . . . . . . **Cynipoidea** p. 800

9. Body not densely hairy 10
Body densely hairy. (Wasps) . . . . **Vespoidea** p. 877

10. First abdominal segment elbowed. (Ichneumon Flies.) . . . . . **Ichneumonoidea**
First abdominal segment not elbowed. (Pointed-tailed Wasps.) . . . . **(Serphoidea) Proctotrupoidea** p. 851

11. Hairs of dorsulum simple, not branched or plumose 12
Hairs of dorsulum branched or plumose . . . . **Apoidea** p. 889

12. Abdomen with more than three segments visible, segments beyond third not hidden . . . . **Sphecoidea** p. 870
Abdomen with three segments visible, segments beyond third hidden. (Cuckoo or Gold Wasps.) . . . . **Chrysidoidea** p. 869

13. Cutting edge of mandibles turned inward, their tips meeting or overlapping when mandibles are flexed toward mouth. (Wasps.) . . . . **Vespoidea** p. 877
Cutting edge of mandibles turned outward, their tips usually neither meeting nor overlapping when mandibles are flexed toward mouth. (Ichneumon Flies.) **Ichneumonoidea**

ICHNEUMONOIDEA (Superfamily) [1]

Parasitic Hymenoptera

The complexity of the classification and nomenclature of this group is such as to render the names of many species uncertain. Descriptions to

[1] W. H. Ashmead, "Class. of Superfamily *Ichneumonoidea*." *Proc. U. S. Nat. Mus.*, 23, pp. 1–220, 1901.
J. C. Bradley, "The *Evaniidæ*." *Trans. Am. Ent. Soc.*, 34, pp. 101–194, 1908.
H. L. Viereck, "Contributions to Knowledge of Ichneumonid Flies, New Descriptions," etc. *Proc. U. S. Nat. Mus.*, 38, pp. 379–384, 1910; 39, pp. 401–408, 1911; 40, pp. 173–196, 475–480, 1911; 42, pp. 139–153, 613–648, 1912; 43, pp. 575–593, 1912; 44, pp. 555–568, 639–648, 1913; 46, pp. 359, 386, 1913. *Type Species of the Genera of Ichneumon Flies.* Bul. 83, U. S. Nat. Mus., pp. 1–186, 1914. Also *Proc. U. S. Nat. Mus.*, 59, pp. 129–150, 1922. "Hym. of Conn." Bul. 22, *Conn. Geol. and Nat. Hist. Survey*, pp. 176–360, 1916.
S. A. Rohwer, "Tribe *Xoridini*." *Proc. U. S. Nat. Mus.*, 45, pp. 353–361, 1913. "Genus *Ecphylus* and Miscl. Spp." *Proc. U. S. Nat. Mus.*, 45, pp. 533–540, 1913. "Miscl. Spp." *Proc. U. S. Nat. Mus.*, 49, pp. 205–249, 1915. "Tribes *Labenini*, *Rhyssini*, *Xoridini*, *Odontomerini*, *Phytodietini*." *Proc. U. S. Nat. Mus.*, 57, pp. 405–474, 1921.
A. B. Gahan, "New Parasitic *Hymenoptera*." *Proc. U. S. Nat. Mus.*, 48, pp. 155–159, 1915; 53, pp. 195–217, 1917; 55, pp. 113–128, 1920; 61, No. 2445, art. 24, pp. 1–24, 1922.
R. A. Cushman, "N. A. Ichneumonid Flies. Miscl. Papers." *Proc. U. S. Nat. Mus.*,

enable exact identification are also out of the question. Many host records are included in the preceding chapters so that some duplication is unavoidable here. In order to conserve space, only the most important facts given in the briefest manner possible will be stated for the different species included.

KEY TO FAMILIES[1]

(Figs. 636, 654)

1. The costal cell of the fore wings eliminated by the coalescence of the costal and subcostal veins, except in the case of two or three rare genera. The venter is membranous and has in dried specimens a longitudinal fold 2
   The costal cell of the fore wings present. The venter is chitinized 4

2. The transverse part of vein M_2 (second recurrent) of the fore wings wanting, causing the union of cells M, and first M_2 3
   Cells M and first M_2 separated by the transverse part of vein M_2 **Ichneumonidæ** p. 790

3. The abdomen not very long and slender and strongly compressed **Braconidæ**
   The abdomen very long, slender and strongly compressed (Genus *Pharsalia*) .... **Ichneumonidæ** p. 790

4. The abdomen borne on the dorsum of the propodeum far above the middle coxæ. 5
   The abdomen borne between the hind coxæ, or on the end of the propodeum slightly above them 6

5. The transverse part of vein M_2 (second recurrent) present in the fore wings, which have at least two closed submarginal cells .... **Aulacidæ**
   The transverse part of vein M_2 (second recurrent) wanting in the fore wings which do not have two closed submarginal cells .... **Gasteruptionidæ**

6. Two or three closed submarginal cells in the fore wings .... **Trigonalidæ**
   Only one closed submarginal cell in the fore wings .... **Stephanidæ**

BRACONIDÆ.[2] Braconid Flies.

Opius aridis Gahan. Length 1.25 mm., black with brown appendages. Parasitic on *Agromyza scutellata* Fallén, Arizona.

Opius dimidiatus (Ashmead) (*Eutrichopsis agromyzæ* Viereck). Parasitic on *Agromyza scutellata* Fallén, Utah.

48, pp. 507–513, 1915; 53, pp. 457–469, 1917; 55, pp. 517–543, 1920; 58, pp. 251–292, 1921; 60, No. 2416, art. 21, pp. 1–28, 1922.

In most cases species are listed under the commonly accepted generic names, but in some groups, particularly the *Pimplinæ* and *Ophioninæ* it has seemed wise to use subgeneric names in the generic sense. The writer has followed S. A. Rohwer, R. A. Cushman and C. F. W. Muesebeck of the U. S. National Museum in this arrangement.

[1] After J. H. Comstock, pp. 906–907, 1924.

[2] W. H. Ashmead, "Syn. of the *Hormiinæ* of N. A." *Trans. Am. Ent. Soc.*, 20, pp. 39–44, 1893.

C. G. de Dalla Torre, "*Cat. Hymenoptera.*" *Braconidæ*, 4, 1908.

A. B. Gahan, *Aphidiinæ of North America.* Bul. 152, Md. Agr. Exp. Sta., pp. 147–200, 1911.

A. B. Gahan, "Rev. of *Ophiinæ.*" *Proc. U. S. Nat. Mus.*, 49, pp. 63–95, 1916.

H. L. Viereck, *Hym. Conn.*, pp. 216–239, 1916.

C. F. W. Muesebeck, "Rev. N. A. *Ichneumonidæ* Belonging to the Subfamilies *Neoneurinæ* and *Microgasterinæ.*" *Proc. U. S. Nat. Mus.*, 61, No. 2436, art. 15, pp. 1–73, 1922.

H. L. Viereck separates the *Vipionidæ* and the *Capitoniidæ* from the *Braconidæ*. They are retained in the latter on the recommendations of A. B. Gahan who has kindly corrected the manuscript of this family and has made many valuable suggestions.

Opius downesi Gahan. Length 3 mm., black with reddish markings. Parasitic on pupæ of *Rhagoletis pomonella* (Walsh) in British Columbia.

Opius pegomyiæ Gahan. Length 3.8 mm., black, the legs excepting the hind coxæ reddish. Parasitic on *Pegomyia hyoscyami* (Panzer) in Southern California.

Opius succineus Gahan. Length 2 mm., brownish yellow. Parasitic on *Agromyza parvicornis* Loew in Utah.

Opius suturalis Gahan. Length 1.25 mm., shining black with appendages partly testaceous. Parasitic on *Agromyza scutellata* Fallén in Arizona.

Opius utahensis Gahan. Length 2.25 mm., reddish brown. Parasitic on *Agromyza parvicornis* Loew in Utah.

Apanteles glomeratus (Linn.).[1] Length 2.6–3 mm., black with yellow and rufous markings. The cocoons are yellow and occur in loose masses. The adults oviposit in the first, second, and third stage caterpillars, laying from 30–60 eggs in each host. The eggs float freely in the body cavity and hatch in a short time. The larvæ feed on the lymph and fatty tissues of the host and mature in 8–12 days. They emerge and spin the cocoons outside the host. From 15–50 may emerge from a single caterpillar. The pupal period requires 5–10 days. The adults emerge through round holes at the ends of the cocoons and are most numerous from August to September. This parasite is European in origin and was introduced into the United States from England in 1883 to control the cabbage butterfly, *Pieris rapæ* (Linn.), and was successfully introduced into California in 1914. It is also known to occur in Colorado and Nevada in the west. Other hosts include *Pieris protodice* Bdv. and Lec., *Vanessa* spp., *Autographa brassicæ* (Riley), and the caterpillars of other butterflies and moths. It is often a very important check to the host.

Apanteles[2] *aristoteliæ* Viereck (*A. gelechiæ* Vier.). Length 2.5 mm., black with antennæ and legs partly brownish. Parasitic on various *Microlepidoptera* in the east and reared from pupæ of *Archips argyrospila* Walker from San José, California, by the writer.

Apanteles acronyctæ Riley. Length 2.5 mm., black with reddish legs. Parasitic on *Acronycta* spp., in many parts of the United States and on *Merolonche lupini* Grote in California, and a bombycid on willow in Colorado.

Apanteles bucculatricis Muesebeck. Length 1.8 mm., black with legs partly pale. Parasitic on *Bucculatrix albertiella* Busck in the San Francisco Bay region, California.

Apanteles electræ Viereck (Fig. 655). Length 2.5 mm., black with legs partly brownish. Parasitic on the caterpillars of *Hemileuca electra* Wright, *H. nevadensis* Stretch, and *Pseudohazis eglanterina* (Bdv.) in California and on *Agapema galbina* Clem. in Arizona. The white cocoons occur in large numbers on the backs of the hosts.

Apanteles californicus Muesebeck. Length 2.8 mm., black. Parasitic on *Recurvaria milleri* Busck in California.

Apanteles cassianus Riley. Parasitic on *Eurymus eurytheme* (Bdv.) and *Eurema nicippe* (Cramer) as far west as Colorado.

Apanteles congregatus (Say). Length 2.5 mm., black, the legs partly yellow, cocoons white and occur in large numbers on the backs of the hosts. General throughout North America and reported in Colorado, Wyoming, and Montana in the west. Parasitic on the caterpillars of *Protoparce sexta* (Johan.), *P. quinquemaculata* (Haw.), *Sphinx chersis* (Hbn.), *Pholus achemon* (Drury), and other sphinx moths.

[1] R. Matheson, *Can. Ent.*, 39, p. 205, 1907.

[2] C. F. W. Muesebeck, "Rev. of N. A. Species of Ichneumon Flies belonging to the Genus *Apanteles*." *Proc. U. S. Nat. Mus.*, 58, No. 2349, pp. 483–576, 1920.

Apanteles ephestiæ Baker. Length 3.6 mm., shining black, usually tips of antennæ and legs rufous. Parasitic on *Ephestia kuehniella* Zeller in Colorado.

Apanteles etiellæ Viereck. Length 2.5 mm., black with portions of the legs testaceous. Parasitic on *Etiella zinckenella* (Treit.) form *schisticolor* Zeller in Colorado and Washington.

Apanteles limenitidis (Riley). Parasitic on *Eurymus eurytheme* (Bdv.) and on *Basilarchia archippus* (Cramer) and ranges west into Utah.

Apanteles forbesi Viereck. Length 3.5 mm., black and dark brown, the legs partly yellow. General throughout the United States and ranges west into Oregon. Parasitic on *Cirphis unipuncta* (Haw.), *Feltia* spp., *Polia stricta* Walker, and other cutworms and armyworms.

Apanteles fumiferanæ Viereck. Length 2.5 mm., black with reddish markings and black stigma. Parasitic on the larvæ of *Harmologa fumiferana* (Clemens) in Oregon. It ranges east into Maine.

Apanteles gillettei Baker. Length 2.5 mm., shining black, tips of antennæ and portions of legs amber or rufous. Parasitic on *Archips argyrospila* Walker in Colorado.

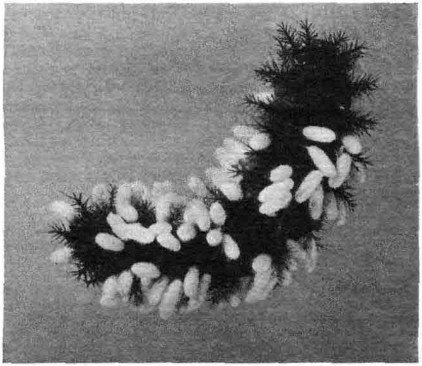


FIG. 655.—Cocoons of *Apanteles electræ* Viereck, on caterpillar of the brown day moth, *Pseudohazis eglanterina* (Bdv.).

Apanteles koebelei Riley. Parasitic on *Euphydryas editha* Bdv. in California.

Apanteles læviceps Ashmead occurs at higher elevations throughout the United States and Southern Canada. In the west it is known in New Mexico, Colorado, and Utah. The cocoons are dirty white to buff and occur in masses. It is parasitic on a large number of caterpillars including *Laphygma exigua* (Hbn.), *Neleucania albilinea* (Hbn.), *Cirphis unipuncta* (Haw.), *Autographa brassicæ* (Riley), *Chorizagrotis agrestis* (Grote), *C. auxiliaris* (Grote), *Loxostege sticticalis* (Linn.), and *Eurymus eurytheme* (Bdv.)

Apanteles laspeyresiæ Viereck. Length 3.5 mm., black with appendages partly reddish. Parasitic on *Carpocapsa toreuta* (Grote) in Northern California.

Apanteles lunatus (Packard) (*Microgaster*). Length 3–3.5 mm., black, legs largely red. The cocoons are yellowish and solitary. Occurs throughout the United States; in California, Oregon, and Washington in the west. Parasitic on *Papilio bairdi* Edw. form *oregonia* Edw., *P. polyxenes* Fabr., *P. zelicaon* Lucas in the west and on other species in the east.

Apanteles nigricornis Muesebeck. Length 2.4 mm., black, the legs mostly reddish brown, cocoons grayish and in compact masses. Reared from *Ctenucha brunnea* Stretch

in Southern California by the writer. The secondary, *Hemiteles fulvipes* Grav., was also reared from the same material.

Apanteles nitens Muesebeck. Length 2 mm., black, portions of legs reddish. Parasitic on *Feltia æneipennis* Grote in Oregon.

Apanteles paranthrenidis Muesebeck. Length 3.8 mm., black, legs partly brown, cocoons large white and occurring in large numbers. Parasitic on *Paranthrene robiniæ* (Hy. Edw.) in Southern California.

Apanteles scutellaris Muesebeck. Length 2.6 mm., black, portions of legs yellow. Parasitic on *Phthorimæa operculella* (Zeller) in Southern California.

Apanteles smerinthi Riley. Length 3 mm., black with orange reddish legs, cocoons white in masses of silk. Occurs throughout the country on sphinx moths. Reared in Northern and Southern California from *Smerinthus ophthalmicus* Bdv.

Apanteles thurberiæ Muesebeck. Length 3.8 mm., black, portions of legs reddish brown, cocoons white, solitary, and occurring within bolls. Parasitic on larvæ of thurberia bollworm, *Thurberiphaga diffusa* (Barnes), in Arizona.

Apanteles yakutatensis Ashmead (*A. hyslopi* Viereck). Length 2 mm., black, legs reddish with posterior tarsi black, cocoons white, in firm mass of silk on host. Parasitic on *Autographa californica* (Speyer), *Agrotis c-nigrum* (Linn.), and other noctuids in Utah, Nevada, California, Oregon, Washington, British Columbia, and Alaska.

Elasmosoma vigilans Cockerell. Length 2 mm., dull and shining black, legs reddish with white tarsi. Adults oviposit from the air on the ant, *Formica subpolita* Mayr, the adults of which are parasitized in Colorado. According to C. F. W. Muesebeck [1] this species may prove to be the female of *Elasmosoma bakeri* Ashm., which occurs in Colorado, New Mexico, and Virginia.

Microgaster comptanæ Viereck. Length 2.5 mm., black with reddish and fuscous legs. Parasitic on *Ancylis comptana* (Fröh.) var. *fragariæ* (Walsh and Riley) in Colorado.

Microgaster facetosa Weed. Length 3.5 mm., shining black, antennæ, ferruginous, legs yellow and fuscous. Common in Eastern United States and ranging west into Colorado, Montana, and British Columbia. Parasitic on *Plathypena scabra* (Fabr.) in the east and on other noctuids in the west.

Microgaster phthorimææ Muesebeck. Length 3.3 mm., black, legs testaceous with bases black. Parasitic on *Phthorimæa operculella* (Zeller) and *Phlyctænia ferrugalis* Hbn. in Southern California.

Microplitis alaskensis Ashmead. Length 4 mm., largely black, portions of legs reddish, cocoons 4.5–5 mm. long, pale greenish, slightly tapering towards one end, solitary. Occurs in Northeastern United States and in Canada and ranges west into Montana, Colorado, California, Oregon, Washington, British Columbia, and Alaska. Parasitic on *Autographa californica* (Speyer), *Neuria procincta* (Grote), and other noctuids.

Microplitis autographæ Muesebeck. Length 3.5 mm., black, portions of legs reddish, cocoons light brown. Parasitic on *Autographa californica* (Speyer) in New Mexico.

Microplitis brassicæ Muesebeck. Length 2.7 mm., black with all except bases of legs testaceous. Parasitic on *Autographa brassicæ* (Riley) in Colorado and Texas.

Microplitis croceipes (Cresson) (*Microgaster, Microplitis nigripennis* Ashm.). Length 4.5 mm., shining black, wings infumated, cocoons 6 mm. long, cylindrical, longitudinally ribbed, pale brown, solitary. Occurs in various parts of the United States and ranges west into New Mexico and Colorado. Parasitic on *Heliothis obsoleta* (Fabr.), *H. virescens* (Fabr.), and other species of this genus.

Microplitis plutellæ Muesebeck. Length 2.2 mm., black, tibiæ testaceous, cocoons 2.5 mm. long, brown, solitary. Parasitic on *Plutella maculipennis* Curtis in Colorado.

Cœloides brunneri Viereck. Length 4 mm., black with reddish head. Parasitic on *Dendroctonus pseudotsugæ* Hopk. in Montana.

Microbracon hyslopi Viereck. Length 3.5 mm., black and reddish, ovipositor as long as abdomen. Parasitic on *Etiella zinckenella* (Treit.) in Washington, Oregon, and Colorado.

Microbracon hebetor (Say) (*Bracon, Habrobracon*) [2] (Fig. 656). Length 2–3 mm., black with yellowish markings, variable in color and size. This species apparently

[1] *Proc. U. S. Nat. Mus.*, 61, No. 2436, art. 15, p. 6, 1922.

[2] R. A. Cushman, "A Rev. of the N. A. Species of the Braconid Genus *Habrobracon*." *Proc. Ent. Soc. Wash.*, 16, pp. 99–109, 1914.

This species has also been known as *Habrobracon juglandis* (Ashmead), but was recently changed to the above by C. F. W. Muesebeck according to A. B. Gahan.

attacks exclusively the *Lepidoptera* in stored grain, dried fruits, etc., and occasionally the bee moth in hives. There is one record of its attacking a moth larva in a bumblebee nest. It occurs throughout the country and is common in California, Nevada, and other Western States. It is parasitic on *Galleria mellonella* (Linn.), *Hulstia undulatella* Clemens, *Phthorimæa operculella* (Zeller), *Ephestia kuehniella* Zeller, *E. elutella* (Hbn.), *E. cautella* Walker, *Plodia interpunctella* (Hbn.). It is abundant on the caterpillars of the last named species in California. The hyperparasite, *Tetrastichus doteni* Crawford, is reported on it in Nevada and probably has a wide distribution.

Microbracon xanthonotus (Ashm.) (*Habrobracon hopkinsi* Vier., *H. mali* Vier.). Length 3–4 mm., black, shining, and pubescent with yellow and testaceous markings. Parasitic on *Malacosoma constricta* (Stretch), *M. pluvialis* (Dyar), and *Hemerocampa oslari* (Barnes) in California.

Microbracon johannseni (Viereck) (*Habrobracon, H. tetralophæ* Vier.). Length 2 mm., antennæ with 22 joints, black and reddish. Parasitic on *Phthorimæa operculella* (Zeller)

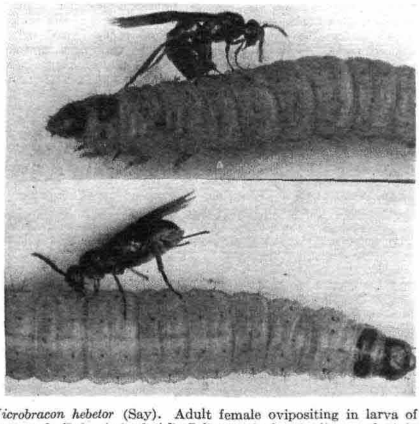


FIG. 656.—*Microbracon hebetor* (Say). Adult female ovipositing in larva of the Mediterranean flour moth, *Ephestia kuehniella* Zeller; and adult feeding on the juices issuing from the puncture after ovipositing. (Photos by S. B. Doten.)

in California; on *Desmia funeralis* Hbn. in Virginia; and on *Tetralopha baptisiella* Fern. in Indiana.

Macrocentrus cerasivoranæ Viereck.[1] Length 8 mm., reddish throughout. Parasitic on *Archips cerasivorana* (Fitch) in Washington. This species ranges east into New York.

Meteorus[2] *communis* (Cresson) (*Perilitus, P. intermedius* Cress., *Meteorus petiolariferus* Vier., *M. pretiosus* Vier.). Length 4–6 mm., yellow-ferruginous marked with black. Occurs throughout the United States and Canada and ranges west into Colorado, Oregon, and British Columbia. As this species has been confused with *M. hyphantriæ* Riley, the host records are mixed. Known hosts are *Neuria procincta* (Grote),

[1] The species beginning here and continuing to the end of the family are included in the *Braconidæ* by Viereck, the preceding species being placed in the *Vipionidæ*.

[2] C. F. W. Muesebeck, "Rev. of N. A. Species of the Genus *Meteorus*." *Proc. U. S. Nat. Mus.*, 673, No. 2470, art. 2, pp. 1–14, 1923.

Graptolitha laticinerea (Grote), *Cirphis unipuncta* (Haw.), *Malacosoma americana* (Fabr.), and other moths.

Meteorus dimidiatus (Cresson) (*M. noctivagus* Vier.). Length 4 mm., shining black with ferruginous markings. Host records are confused with those of *M. vulgaris* (Cress.), but it is known to be parasitic on *Desmia funeralis* Hbn. Occurs throughout much of the United States and Canada and is recorded in Colorado, Utah, California, and Washington in the west.

Meteorus euschausiæ Muesebeck. Length 5.3 mm., ferruginous with blackish petiole. Parasitic on *Halisidota ingens* Hy. Edw., in Colorado, New Mexico, Arizona, and Mexico.

Meteorus humilis (Cresson) (*Perilitus*, *P. robustus* Prov., *Meteorus orchesiæ* Ashm., *M. agilis* Vier.). Occurs throughout the east and ranges west into Colorado and Oregon. Parasitic on *Tinea oregonella* Busck in Oregon and on the weevils, *Orchesia castanea* Melsh. and *Platydema ellipticum* (Fabr.) in the east.

Meteorus hyphantriæ Riley (*M. œcopsidis* Ashm., *M. floridanus* Ashm., *M. relativus* Vier., *M. triangularis* Mues.). Length 5 mm., variable yellowish, reddish brown, and black. Widely distributed over the United States and Canada, and recorded in New Mexico, California, and Oregon in the west. Parasitic on *Hyphantria cunea* (Drury), *H. textor* (Harris), *Malacosoma americana* (Fabr.), *M. disstria* Hbn., *Cænurgia erechtea* (Cramer), *Neleucania albilinea* (Hbn.), *Halisidota argentata* Pack., *Hemileuca maia* Drury, *Paleacrita vernata* (Peck), *Alsophila pometaria* (Harris), *Hemerocampa leucostigma* (A. & S.), and other *Lepidoptera*.

Meteorus loxostegei Viereck. Length 4 mm. Parasitic on *Pyrausta futilalis* Lederer and *P. nubilalis* Hübner in the eastern United States, and on *Loxostege sticticalis* (Linn.) in Colorado and New Mexico.

Meteorus trachynotus Viereck (*M. archipsidis* Vier.). Length 4.5 mm., pale yellow to brown, antennæ with 32–34 segments and as long as the body, cocoons very thin and white. Occurs in northern United States and Canada. Parasitic on *Archips argyrospila* Walker in California; *Harmologa fumiferana* (Clem.) in Idaho and British Columbia; *Ancylis comptana* (Fröh.) in Utah, and on other *Lepidoptera* elsewhere. In the west it is also known in Colorado.

Meterous vulgaris (Cresson) (*M. coquilletti* Ashmead, *M. mellinervis* Viereck, *M. mamestræ* Vier.). Length 4 mm., ferruginous with dark dorsal markings on the thorax and base of the abdomen, antennæ of the female 26–30 segments, of male 29–32. This is the most widely distributed, abundant, and beneficial species of this genus in North America and is reported in the west from New Mexico, Colorado, Montana, Arizona, Utah, California, Oregon, and British Columbia, and undoubtedly occurs in all the other States. There are at least two generations, the adults appearing in May and again in July. About 12 eggs are laid in each host, within which the larvæ of the last brood spend the winter.[1] This species has often been confused with a number of others and many host records are thus wrongly determined. According to C. F. W. Muesebeck [2] the following hosts are ascribed to this species: *Porosagrotis orthogonia* Morrison, *Euxoa excellens* (Grote), *Chorizagrotis agrestis* (Grote), *Feltia annexa* (Treit.), *F. subgothica* (Haw.), *F. malefida* (Gn.), *F. gladiaria* Morr., *Agrotis ypsilon* (Rott.), *Lycophotia margaritosa* (Haw.), *Scotogramma trifolii* (Rott.), *Sidemia devastator* (Brace), and *Hellula undalis* (Fabr.), all in various parts of the country.

The ladybird beetle parasite, *Dinocampus coccinellæ* (Schrank) [*D. americanus* (Riley), *Perilitus*, *Euphorus sculptus* Cress.][3] (Fig. 657.) Length 3.5–4 mm., black with head

[1] E. H. Strickland, *Can. Ent.*, 53, p. 98, 1921. Confused with *M. dimidiatus* (Cress.).
[2] *Proc. U. S. Nat. Mus.*, 63, No. 2470, art. 2, p. 32, 1923.
[3] R. A. Cushman, *Proc. Ent. Soc. Wash.*, 15, pp. 153–155, 1913; 24, pp. 241–242, 1922. P. H. Timberlake, *Can. Ent.*, 47, p. 89, 1916.

and portions of antennæ and legs yellowish. A common parasite of ladybird beetles, *Coccinellidæ*, throughout the United States. The females oviposit in the larvæ, pupæ, and adults of the host. The parasites do not destroy the vital organs but greatly devitalize the host so that death soon follows the issuance of the mature larvæ. Vigorous beetles may recover. The larvæ exit through a hole in the ventral or dorsal surface and spin a small, oval, brown cocoon beneath the body of the adult ladybird beetle which is thus attached to a leaf, twig, or other object. This parasite occurs throughout the west and has been reared from a large number of genera and species of ladybird beetles including *Hippodamia convergens* Guér., *H. quinquesignata* Kirby, *H. parenthesis* (Say),

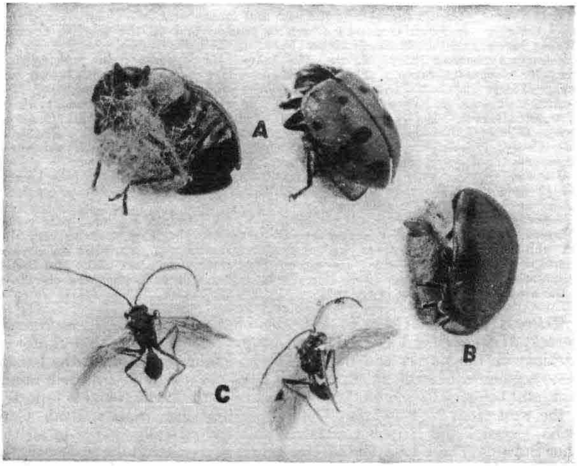


FIG. 657.—The ladybird beetle parasite, *Dinocampus coccinellæ* (Schrank). A, cocoons on the venter of the convergent ladybird beetle, *Hippodamia convergens* Guér.; B, cocoon attached beneath the California ladybird beetle, *Coccinella californica* Mann.; C, adult parasites.

H. sinuata Muls. var. *spuria* Lec., *Coccinella californica* Mann., *C. perplexa* Muls. var. *juliana* Muls., *C. novemnotata* Hbst., *Cycloneda munda* (Say), *Olla abdominalis* (Say), *Adalia frigida* (Schn.), *Ceratomegilla fuscilabris* (Muls.). *Dinocampus terminatus* (Nees) is a European and American species reared from *Olla abdominalis* (Say) in California by P. H. Timberlake.

Bassus carpocapsæ Cushman. Length 4.5 mm., black, legs and abdomen reddish brown. Parasitic on *Carpocapsa pomonella* (Linn.) in the east and established at Yakima, Washington, by E. J. Newcomer.[1]

Bassus medius (Cresson) (*Microdus*). Length 6 mm., black and reddish with dusky wings. Parasitic on *Scotogramma trifolii* (Rott.) in Colorado.

Bracon[2] *vulgaris* (Cresson) (*Agathis*, *A. media* Cress., *A. exoratus* Cress.). Length

[1] *Jour. Econ. Ent.*, 15, p. 378, 1922.

[2] H. Morrison, "Mon. of the Nearctic *Hymenoptera* of the Genus *Bracon* Fabricius." *Proc. U. S. Nat. Mus.*, 52, No. 2178, pp. 305–343, 1917.

6.5–9.5 mm., mostly red, orange or yellow with the head black. Distributed over the United States and known in Colorado, New Mexico, Arizona, and Oregon in the west. Parasitic on *Loxostege sticticalis* (Linn.) in Colorado.[1]

Bracon euuræ Ashmead. Length 2.6 mm., pale yellow and black. Parasitic on *Euura* sp. on willow in California. According to Muesebeck's *manuscript this is a synonym of Microbracon angelesius* (Prov.) (S. A. Rohwer).

Doryctes cingulata (Provancher) (*Syngaster cingulatus* Prov.). Length 3.5 mm., black and reddish. Parasitic on the larvæ of *Chrysobothris mali* Horn in Oregon.

Doryctes maculipennis Rohwer. Length 3.5 mm., black, wings with fuscous spots.

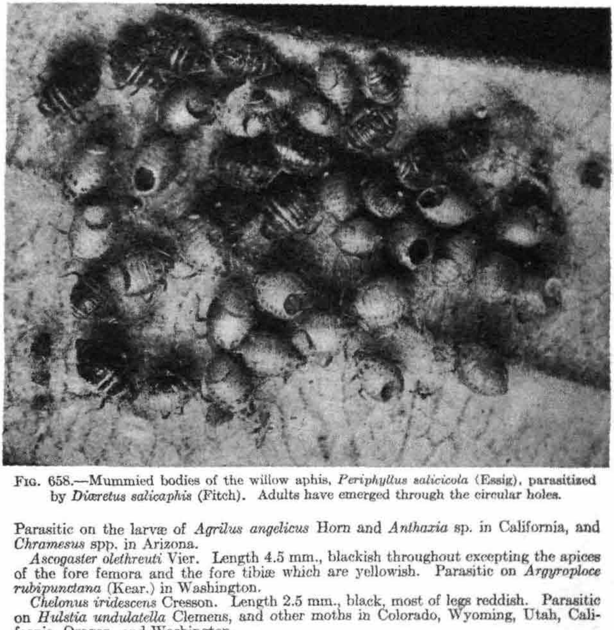


FIG. 658.—Mummied bodies of the willow aphis, *Periphyllus salicicola* (Essig), parasitized by *Diæretus salicaphis* (Fitch). Adults have emerged through the circular holes.

Parasitic on the larvæ of *Agrilus angelicus* Horn and *Anthaxia* sp. in California, and *Chramesus* spp. in Arizona.

Ascogaster olethreuti Vier. Length 4.5 mm., blackish throughout excepting the apices of the fore femora and the fore tibiæ which are yellowish. Parasitic on *Argyroploce rubipunctana* (Kear.) in Washington.

Chelonus iridescens Cresson. Length 2.5 mm., black, most of legs reddish. Parasitic on *Hulstia undulatella* Clemens, and other moths in Colorado, Wyoming, Utah, California, Oregon, and Washington.

Chelonus phthorimææ Gahan. Length 3 mm., black, femora and tibiæ piceous or reddish, antennæ 16-jointed. Parasitic on *Phthorimæa operculella* (Zeller) in Southern California and in Colorado.

Sigalphus texanus Cresson (*Schizoprymnus*). Length 4 mm., black, basal portion of antennæ yellowish, legs reddish. Parasitic on *Eurosta solidaginis* (Fitch) in the galls on the stems of goldenrod in Utah and Colorado.

[1] C. P. Gillette, Bul. 98, Colo. Agr. Exp. Sta., p. 10, 1905.
H. O. Marsh, Bul. 109, pt. 6, Bur. Ent. U. S. Dept. Agr., p. 62, 1912.

Phanerotoma erythrocephala Rohwer. Length 5 mm., black, with portions of the head and legs reddish brown. Parasitic on *Carpocapsa toreuta* (Grote) in the cones of yellow pine in Colorado. *Phanerotoma laspeyresia* Rohwer attacks the same host in California.

Rogas[1] *autographæ* Viereck (*Aleiodes*). Length 4 mm., black and ferruginous. Parasitic on *Autographa californica* (Speyer) in Washington and California.

Rogas intermedius (Cresson). Length 4 mm., dull yellow to amber, the basal abdominal segment mostly fuscous or black. Parasitic on young larvæ of *Malacosoma disstria* Hbn., which are usually killed before half grown. The adults emerge through a hole in the dorsum near the posterior end. Reared by the writer from caterpillars collected at Santa Rosa, California. Also occurs in Colorado and Eastern States.

Rogas perplexus Gahan. Length 3.8 mm., dark yellowish brown with black markings.

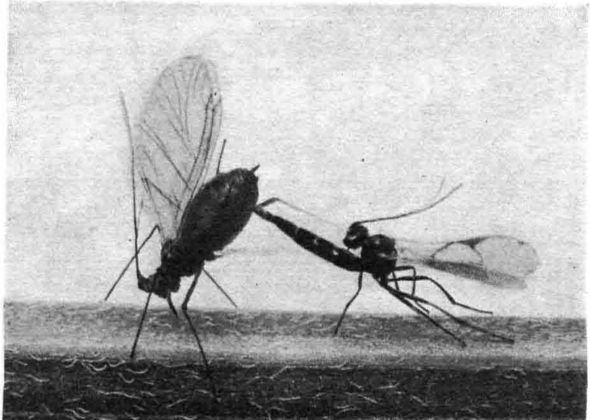


FIG. 659.—Adult *Lysiphlebus testaceipes* (Cresson) ovipositing in body of the alfalfa aphis, *Illinoia creeli* (Davis). (Photo by S. B. Doten.)

Parasitic on *Lycophotia margaritosa* (Haw.) in Arizona and on *Heliothis obsoleta* (Fabr.) in New Mexico.

Rogas rufocoxalis (Gahan). Length 5.6 mm., head, antennæ, legs, excepting coxæ black; thorax, abdomen, and coxæ reddish brown. Parasitic on *Autographa californica* (Speyer) and *A. brassicæ* (Riley) in Colorado and on *Phlyctænia ferrugalis* Hbn. in Southern California (R. E. Campbell). The record from *Lycophotia margaritosa* (Haw.) is an error according to A. B. Gahan.

Ephedrus[2] *incompletus* Provancher. Length 2.5 mm., black, legs and abdomen mostly pale yellow. Parasitic on *Myzus cerasi* (Fabr.), *Macrosiphum rosæ* (Linn.), and other *Aphididæ* throughout the country. *Ephedrus californicus* Baker is 2.25 mm. long,

[1] *Rogas* or *Rhogas* of authors not Nees. *Aleoides* is a synonym.

[2] The genera *Ephedrus*, *Praon*, and *Aphidius* are included in the family *Ichneumonidæ* by Viereck in *Hymenoptera of Connecticut*.

shining black, with bases of tibiæ yellowish. It occurs in California. *E. nevadensis* Baker is 2 mm., black with reddish legs, occurring in Nevada.

Praon coloradensis Ashmead. Length 1.5–2 mm., shining black with yellowish legs. Parasitic on *Periphyllus negundinis* (Thomas) and on *Macrosiphum* spp., in Colorado.

Trioxys coruscanigrans Gahan. Length 2 mm., black, the posterior portion of the abdomen and the exserted ovipositor yellow. Parasitic on *Macrosiphum artemisiæ* (Fonsc.) in Colorado.

Trioxys cupressicola Gahan. Length 1.65 mm., shining black with most of the legs and the base and tip of the abdomen yellowish. Parasitic on *Siphonatrophia cupressi* (Swain) in Southern California.

Diæretus chenopodiaphidis (Ashmead) (*Lipolexis*). Length 2 mm., shining black, antennæ and portions of the legs yellowish, and the abdomen brownish. Parasitic on *Aphis rumicis* Linn. in California and on *Aphis* spp. in Colorado.

Diæretus fuscicornis (Ashmead) (*Lipolexis*). Length 2 mm., shining black, legs and

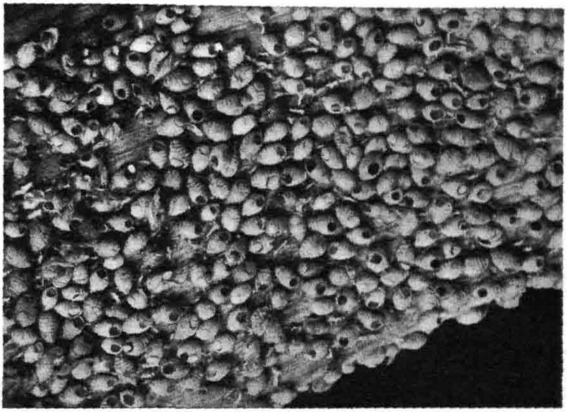


FIG. 660.—Mummied bodies of the corn aphis, *Aphis maidis* Fitch, on corn leaf, parasitized by *Lysiphlebus testaceipes* (Cresson). Adults emerged through the circular holes. This was a case of practically 100 per cent parasitism.

base of abdomen reddish, and remainder of abdomen brownish black. Reared from *Anuraphis middletoni* (Thos.) in Southern California by the writer.

Diæretus rapæ (Curtis) (*D. californicus* Baker). Length 2 mm., head and thorax shining black, abdomen black or reddish brown. Parasitic on *Brevicoryne brassicæ* (Linn.) and occurs in Europe and throughout North America, being very common in the Western States.

Diæretus salicaphis (Fitch) (*Trioxys*) (Fig. 658). Length 1.5 mm., colo⁻ variable but usually blackish, the legs and petiole yellowish. Parasitic on *Periphyllus populicola* (Thomas) and *P. salicicola* (Essig) in Colorado and California. It attacks the former in the Eastern States.

Aphidius confusus Ashmead. Length 2 mm., shining black, most of legs and abdomen yellowish or brownish. Parasitic on *Toxoptera aurantiæ* Koch in Southern California.

Aphidius nigrovarius Provancher. Length 2–3 mm., amber with black markings. Parasitic on *Periphyllus salicicola* (Essig) in California.

Aphidius rosæ Haliday. Length 2–2.5 mm., usually yellowish or reddish brown with

black markings on the head and portions of the antennæ, and the sheath of the ovipositor black. Parasitic on *Macrosiphum rosæ* (Linn.), *M. albifrons* Essig, and *Illinoia pisi* (Kalt.). It occurs in Europe, various parts of the United States, and is common in California.

Lysiphlebus flavidus Gahan. Length 2 mm., reddish with black markings on the head. Parasitic on *Aphis albipes* Oestlund in Colorado.

Lysiphlebus testaceipes (Cresson) (*Aphidius*;[1] (Figs. 659, 660) has a long list of synonyms which indicates its variable color and wide distribution. The females are usually 2 mm. long, shining black, the legs testaceous, the abdomen brown or pale dusky with the first and part of the second segments pale yellowish. This and other species hibernate as larvæ and pupæ in the dead bodies of the host. Parasitic on a large number of *Aphididæ* throughout the country and on the following western species: *Anuraphis middletoni* (Thos.), *A. roseus* Baker, *Aphis cornifoliæ* Fitch, *A. cusutæ* Davis, *A. gossypii* Glover, *A. hederæ* Kalt., *A. maidis* Fitch, *A. medicaginis* Koch, *A. nerii* Fonsc., *A. œnotheræ* Oest., *A. pomi* De Geer, *A. ramonæ* Swain, *A. rumicis* Linn., *Brevicoryne brassicæ* (Linn.), *Hysteroneura setariæ* (Thos.), *Macrosiphum granarium* (Kirby), *Rhopalosiphum pseudobrassicæ* (Davis), *Myzus persicæ* (Sulzer), *Phorodon humuli* (Schrank), *Toxoptera graminum* Rond., *Illinoia creeli* (Davis), and other species.

Monoctonus secundus Viereck. Reared from *Aphis rumicis* Linn. at Berkeley, California.

ICHNEUMONIDÆ.[2] Ichneumonid Flies.

Sagaritis provancheri (Dalla Torre) (*Mesoleptus dubitatus* Cresson). Length 5.5 mm., black, trochanters bright yellow, remainder of legs reddish and dusky, posterior margins of abdominal segments reddish brown. Common throughout the United States and Canada. Reared from *Plutella maculipennis* Curtis in Colorado by C. P. Gillette, and recorded in California and British Columbia. The variety *websteri* (Viereck) (*S. websteri* Viereck) is an effective parasite of *Autographa californica* (Speyer) in California, Oregon, and Washington. The cocoons are bluntly oval, white, mottled brown, and 6.5 mm. long.

[1] F. M. Webster and W. J. Phillips, Bul. 110, Bur. Ent. U. S. Dept. Agr., p. 104, 1912.

[2] E. T. Cresson, "N. A. Species." *Proc. Ent. Soc. Philadelphia*, 3, pp. 135–186, 257–320, 1864; 4, pp. 245–303, 1865. *Trans. Am. Ent. Soc.*, 1, pp. 289–312, 1867; 6, pp. 129–212, 1877.

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R. A. Cushman, "Rev. of *Cremastini* of Am. North of Mexico." *Proc. U. S. Nat. Mus.*, 53, pp. 503–551, 1917. "Tribe *Ephialtini*." *Ibid.*, 58, pp. 327–362, 1921. "Genera *Clistopyga* and *Schizopyga*." *Ibid.*, 60, No. 2399, art. 4, pp. 1–14, 1922. "Ashmead Manuscript *Ichneumonidæ*." *Ibid.*, 61, No. 2429, art. 8, pp. 1–30, 1922. "Tribe *Paniscini*." *Ibid.*, 64, No. 2510, art. 20, pp. 1–48, 1924.

R. A. Cushman and S. A. Rohwer, "Subfamily *Ichneumoninæ*." *Proc. U. S. Nat. Mus.*, 57, pp. 379–396, 1921. "Tribe *Acænitini*." *Ibid.*, 57, pp. 503–523, 1921.

For Key to Tribes of *Ichneumoninæ*, see R. A. Cushman and S. A. Rohwer. *Proc. U. S. Nat. Mus.*, 57, pp. 388–392, 1921.

Campoplex epinotiæ Viereck. Length 7 mm., distinguished by black femora. Parasitic on *Enarmonia arctostaphylana* (Kearfott) in California.

Campoplex phthorimææ (Cushman) (*Omorgus*). Length 5 mm., ovipositor 1.25 mm., black with whitish and rufous markings. Parasitic on *Phthorimæa operculella* (Zeller) in Southern California.

Nemeritis canescens (Gravenhorst). Small black and reddish European species reared from *Ephestia kuehniella* Zeller at San Francisco, California, by the writer.

Campoletidea caradrinæ Viereck. Length 8 mm. Parasitic on *Laphygma exigua* (Hbn.) in Colorado.

Bathyplectes curculionis (Thomson) (*Canidiella*). A European species introduced into Utah, Idaho, Nevada, and Colorado to prey on *Phytonomus posticus* (Gyll.).

Bathyplectes exiguus (Gravenhorst). A European species introduced into various

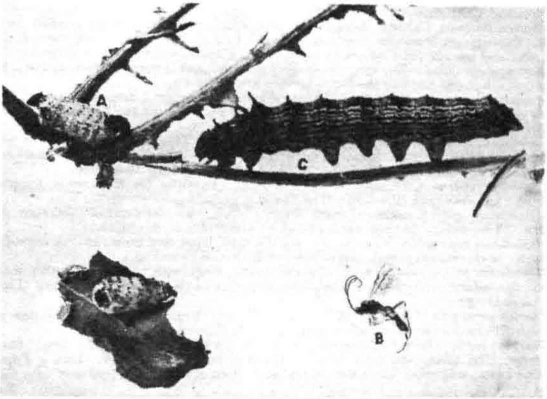

FIG. 661.—*Hyposoter fugitivus* (Say). A, cocoons within the shriveled bodies of the red-humped caterpillar, *Schizura concinna* (A and S), from which adults have emerged; B, adult; C, normal full-grown non-parasitized red-humped caterpillar, and work on prune leaves.

parts of the United States. It is parasitic on *Hypera punctata* (Fabr.) in Oregon and Washington and on *Hypera* spp., elsewhere.

Hypothereutes exiguæ Viereck. Length 5.5 mm., black, most of legs and apical half of abdomen reddish. Parasitic on *Laphygma exigua* (Hbn.) in California.

Hypothereutes nigrolineatus Viereck. Length 5 mm., black and reddish, the first abdominal segment entirely black, the second mostly black, and the remainder with a black dorsal stripe. Parasitic on *Neleucania albilinea* (Hbn.) in New Mexico.

Angitia polynesialis (Cameron) [*Angitia hellulæ* (Vier.), *A. plutellæ* Vier.]. Length 4 mm., black, the middle coxæ reddish, fore trochanters pale yellow, and third, fourth, and fifth abdominal segments partly reddish on the sides. Parasitic on *Hellula undalis* (Fabr.) in California; and on *Plutella omissa* Wlshm. in Colorado; and also on *Plutella maculipennis* Curtis in various parts of the United States. It also occurs in Hawaii. It is parasitized by the secondary, *Spilochalcis delira* (Cresson).

Angitia milleri Rohwer. Length 4.5 mm., ovipositor 1.25 mm., antennæ 4.5 mm., black, legs ferruginous. Parasitic on immature stages of *Dioryctria abietella* D. & S. in cones of sugar pine in Oregon.

Hyposoter fugitivus (Say) (*Banchus*, *Limnerium*, *Ameloctonus*) (Fig. 661). Length

8 mm., black, legs partially yellow, cocoons cylindrical white with two brown bands. Common throughout the United States and parasitic on *Hyphantria textor* (Harris), *Malacosoma americana* (Fabr.), *M. disstria* Hbn., *Hemileuca maia* Drury, *Ephestia kuehniella* Zeller, *Vanessa cardui* (Linn.), and many other *Lepidoptera*. It is rarely parasitized by the secondary, *Itoplectis conquisitor* (Say). The variety *pacificus* Cushman, is the western form of this species and occurs from California into British Columbia and has been reared from *Malacosoma pluvialis* (Dyar), *M. ambisimilis* (Dyar), and *Schizura concinna* (A. & S.) in California by the writer.

Meloborus[1] *laspeyresiæ* (Rohwer). Length 7.5 mm., ovipositor 1.25 mm., black, portions of head yellow, legs whitish and rufous. Parasitic on *Carpocapsa toreuta* (Grote) in Oregon.

Pyracmon conocola Rohwer. Length 7.5 mm., black, pubescent, legs largely red. Parasitic on *Barbara colfaxiana* (Kearf.) var. *taxifoliella* (Busck), and *Pinipestis* sp. in Oregon and California.

Nepiera benevola Gahan. Length 4.5 mm., black with yellow and reddish markings. Parasitic on *Eurymus eurytheme* (Bdv.) in Utah. The variety *fuscifemora* Gahan is 6 mm. and has the hind femora broadly striped blackish or fuscous. It is parasitic on *Phthorimæa operculella* (Zeller) in Southern California, and is very common at Berkeley, California, but the hosts in the latter locality are unknown.

Cremastus platynotæ Cushman. Length 6 mm., ovipositor 3 mm., antennæ 2 mm., black marked with yellow, legs largely testaceous with whitish trochanters. Parasitic on *Sparganothis flavedana* Clem. in Arizona.

Cremastus facilis (Cresson) (*Porizon*, *P. macer* Cress., *Temelucha*). Length 6–8 mm., yellow or reddish with black markings or black with yellowish and reddish markings. Parasitic on *Hellula undalis* (Fabr.) in the Eastern States and New Mexico.

Cremastus evetriæ Cushman. Length 6 mm. Parasitic on *Rhyacionia frustrana* (Comst.) var. *bushnelli* (Busck) in New Mexico.

Mesochorus agilis Cresson. Length 8 mm., black, legs and band on abdomen pale yellow. A secondary parasite on *Loxostege sticticalis* (Linn.) in Colorado.

Mesochorus diversicolor Viereck. Length 3.5 mm., black and brownish. A secondary parasite on *Harmologa fumiferana* (Clemens) in British Columbia.

Mesochorus perniciosus Viereck. Length 5 mm., black with yellow and brown markings. Secondary through *Apanteles læviceps* Ashmead on *Loxostege sticticalis* (Linn.) in Colorado.

Therion acronyctæ (Ashmead) (*Exochilum*). Length 26 mm., black, mottled yellow and reddish. Parasitic on *Merolonche lupini* (Grote) in California.

Therion morio (Fabr.) [*Exochilum mundum* (Say)]. Length 22–24 mm., black, antennæ, hind tibiæ, and tarsi yellow. Parasitic on *Vanessa cardui* (Linn.), *Papilio glaucus* Linn., and other butterflies in eastern United States and ranges west into Colorado.

Trichomma epischniæ Viereck. Length 11.5 mm., ferruginous with dark markings. Parasitic on the pyralid moth, *Epischnia granitella* Rag., in California. *Trichomma granitellæ* Vier. is parasitic on the same host and may be the male of the preceding species.

Ophion abnormis Felt. Length 13–18 mm., amber brown with many conspicuous white lines and specks on the head and thorax. Occurs in the middle west and is reported in Colorado, Montana, California, and Washington. The variety *magniceps* Hooker is the western phase which has been reared from *Sabulodes caberata* Gn. by the writer at Berkeley, California.

Ophion bifoveolatus Brullé. Length 12–22 mm., pale to dark reddish brown. Parasitic on the grubs of *Phyllophaga* spp., throughout North America and recorded in Colorado, Montana, and California. The variety *nigrovarius* (Prov.) is recognized in Colorado and British Columbia.

Ophion bilineatus Say. Length 10–20 mm., varying in color from pale yellowish to reddish brown. One of the commonest species occurring throughout boreal North America and abundant in Texas, New Mexico, Colorado, Wyoming, Montana, California, Nevada, Oregon, Washington, British Columbia, and Alaska, and no doubt also in Utah and Idaho. It is parasitic on the larvæ and pupæ of a large number of *Lepidoptera* including *Epargyreus tityrus* (Fabr.), *Telea polyphemus* (Cramer), *Samia cecropia* (Linn.), *S. euyralus* (Bdv.), *Halisidota caryæ* (Harris), *H. maculata* (Harris), *Diacrisia virginica* (Fabr.), *Feltia gladiaria* Morr., *Conistra inulta* (Grote), *Prodenia*

[1] H. L. Viereck places this as a subgenus of *Campoplex*.

eridania Cram., *Laphygma frugiperda* (A. & S.), *L. exigua* (Hbn.), *Symmerista albifrons* (A. & S.), *Sabulodes caberata* Gn., and other arctiid and noctuid moths.

Eremotylus arctiæ Ashmead. Length 12–28 mm., antennæ 10–25 mm., reddish amber, often with fuscous areas. Occurs throughout North America and is common in California and other Western States. Parasitic on *Estigmene acræa* (Drury), *Halisidota maculata* (Harris), and *Automeris io* (Fabr.) in California and on various *Lepidoptera* elsewhere.

Eremotylus macrurus (Linn.) (Figs. 636, 663). Length 22–38 mm., antennæ 18–33 mm., wholly amber or ferruginous in color. Occurs throughout Central and North Amer-

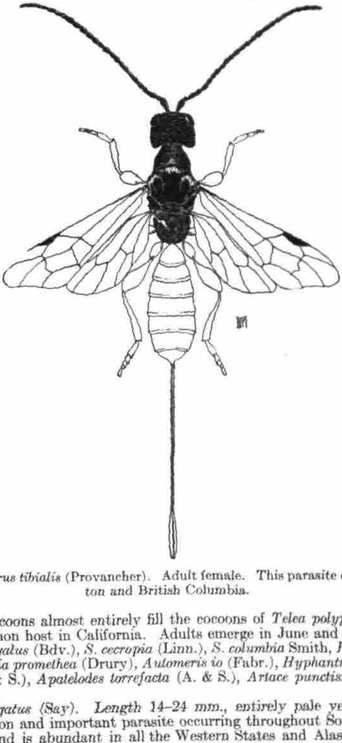

FIG. 662.—*Aplomerus tibialis* (Provancher). Adult female. This parasite occurs in Washington and British Columbia.

ica. The large cocoons almost entirely fill the cocoons of *Telea polyphemus* (Cramer), which is the common host in California. Adults emerge in June and July. Also parasitic on *Samia euryalus* (Bdv.), *S. cecropia* (Linn.), *S. columbia* Smith, *Philosamia cynthia* (Drury), *Callosamia promethea* (Drury), *Automeris io* (Fabr.), *Hyphantria cunea* (Drury), *Isia isabella* (A. & S.), *Apatelodes torrefacta* (A. & S.), *Artace punctistriga* Walker, and other *Lepidoptera*.

Enicospilus purgatus (Say). Length 14–24 mm., entirely pale yellowish brown or fulvous. A common and important parasite occurring throughout South, Central, and North America, and is abundant in all the Western States and Alaska. Parasitic on *Telea polyphemus* (Cramer), *Scotogramma trifolii* (Rott.), *Ceramica picta* (Harris), *Lycophotia margaritosa* (Haw.), *Cirphis unipuncta* (Haw.), *Alabama argillacea* (Hbn.),

Schizura concinna (A. & S.), *S. unicornis* (A. & S.), *Scoliopteryx libatrix* (Linn.), *Drepana bilineata* Pack., *Sabulodes caberata* Gn.

Mesoleius balteatus Cushman. Length 7 mm., antennæ 6 mm., black with legs and abdomen partly reddish. Parasitic on *Ametastegia glabrata* Fallén in Washington.

Mesoleius gymnonychi Rohwer. Length 4 mm., black with yellow markings. Parasitic on *Diphadnus californicus* (Marlatt) in Washington.

Holmgrenia euuræ (Ashm.) (*Bassus*). Length 5 mm., black with white and yellow markings. Parasitic on *Pontania resinicola* Marlatt in Eldorado County, California.

Syrphoctonus agilis (Cresson) (*Bassus*). Length 5 mm., black with antennæ and legs reddish brown. Common throughout boreal North America and ranging west into British Columbia. Parasitic on larvæ and pupæ of *Syrphidæ*.

Syrphoctonus pacificus (Cresson) (*Bassus*). Length 5 mm., black with legs and middle of abdomen reddish. Parasitic on *Lasiophthicus pyrastri* (Linn.) and other syrphid flies in California, Nevada, Oregon, Washington, and British Columbia.

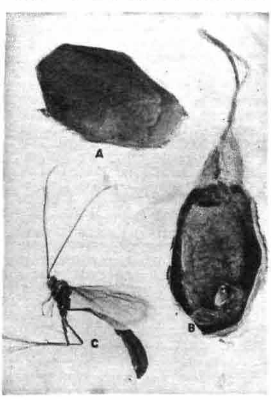

FIG. 663.—*Eremotylus macrurus* (Linn.). A, cocoon of the polyphemus moth, *Telea polyphemus* (Cramer); B, cocoon of the polyphemus moth with side removed to show cocoon of parasite within; C, adult parasite.

Syrphoctonus maculifrons (Cresson). Length 5–7.5 mm., black, legs reddish, and body with white or yellow markings and rings. Parasitic on *Chilosia alaskensis* Hunter, *C. hoodiana* (Bigot), *Lasiophthicus pyrastri* (Linn.), and other syrphid flies in Colorado, Montana, Nevada, California, and other Western and Middle States.

Diplazon lætatorius (Fabr.) (*Bassus*, *Anomalon*).[1] Length 5–8 mm., black, antennæ, legs, and abdomen reddish. The adults oviposit in the eggs of the hosts. The eggs hatch together and the larvæ of the parasite do not fully mature until the pupal stage of the host is reached. A cosmopolitan species occurring throughout North America and common in Arizona, California, and other Western States. Parasitic on *Eupeodes volucris* O. S., *Syrphus americanus* Wied., *S. opinator* O. S., *S. torvus* O. S., *Allograpta obliqua* (Say), *A. fracta* O. S., and other *Syrphidæ*.

Exochus evetriæ Rohwer. Length 6 mm., black, legs largely reddish brown. Parasitic on *Barbara colfaxiana* (Kearfott) vars. *taxifoliella* (Busck) and *siskiyouana* (Kearfott) in Oregon. The eastern *Exochus propinquus* Cresson, is quite common in California but host records are unknown here.

Lissonota evetriæ Rohwer. Length 6.5 mm., black with white markings on head and thorax, legs dusky and reddish. Parasitic on *Barbara colfaxiana* (Kearfott) in Oregon.

Conoblasta fumiferana (Viereck). Length 7.5 mm., black with legs mostly blackish, remainder reddish. Parasitic on *Harmologa fumiferana* (Clemens) in British Columbia.

Glypta evetriæ Cushman. Length 8 mm., ovipositor 6–7 mm., black with reddish legs. Parasitic on *Barbara colfaxiana* (Kearfott) var. *taxifoliella* (Busck) in Oregon.

Xorides cincticornis (Cresson) (*Xylonomus*, *X. modestus* Rohwer). Length 20 mm., ovipositor longer than the body, black with tarsi brownish. Parasitic on immature stages of *Leptura* spp., in Colorado, Oregon, and Washington.

Xorides californicus (Cresson) (*Xylonomus*). Length 20 mm., ferruginous to dusky or black. Parasitic on *Buprestis læviventris* (Lec.) in California.

Xorides insularis (Cresson) (*Pœmenia*, *Xylonomus*). Length 18–20 mm., black and reddish brown. Parasitic on *Melanophila fulvoguttata* (Harris) var. *drummondi* (Kirby), *Tetropium cinnamopterum* Kirby, *T. velutinum* Lec., *Hemicallidium amethystinum* (Lec.),

[1] E. O. G. Kelly, *Jour. Econ. Ent.*, 7, pp. 294–297, 1914.

Semanotus lignea (Fabr.), and *Atimia dorsalis* Lec. in California, Oregon, Washington, and British Columbia.

Xorides neoclyti (Rohwer) (*Mœrophora*). Length 12–14.5 mm., black with reddish abdomen. Parasitic on *Neoclytus caprea* (Say) in Arizona.

Xorides catomus (Davis) (*Xylonomus*). Length 22 mm., ovipositor 23 mm., black to reddish. Parasitic on *Alaus oculatus* (Linn.) and *Chalcophora angulicollis* (Lec.) in Colorado, Montana, Idaho, Oregon, and California.

Deuteroxorides borealis (Cresson) (*Xorides, X. occidentalis* Cress.). Length 12 mm., ovipositor as long as abdomen, black with whitish markings. Occurs throughout boreal North America and in Colorado, Montana, Washington, California, and British Columbia in the west. Parasitic on *Atimia dorsalis* Lec., *Semanotus lignea* (Fabr.), and *Tetropium velutinum* Lec.

Pœmenia americana (Cresson) (*Euxorides*). Length 8–12 mm., black with white and yellowish markings. Easily recognized by short ovipositor. Occurs in many parts of the United States and reported in Colorado, California, and Oregon in the west. Parasitic on *Paratimia conicola* Fisher, and probably erroneously recorded on *Carpocapsa toreuta* (Grote).

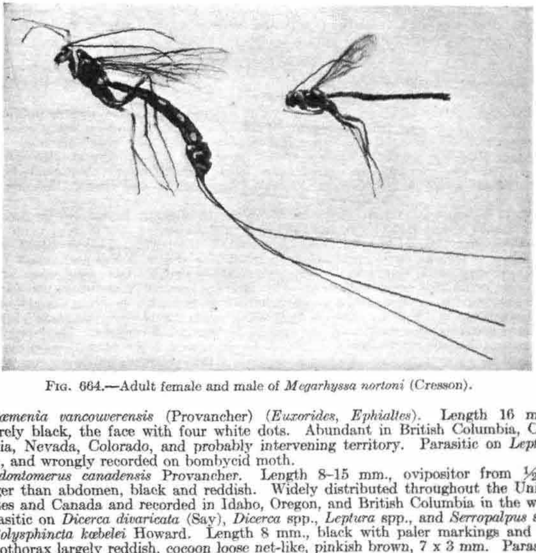

FIG. 664.—Adult female and male of *Megarhyssa nortoni* (Cresson).

Pœmenia vancouverensis (Provancher) (*Euxorides, Ephialtes*). Length 16 mm., entirely black, the face with four white dots. Abundant in British Columbia, California, Nevada, Colorado, and probably intervening territory. Parasitic on *Leptura* spp., and wrongly recorded on bombycid moth.

Odontomerus canadensis Provancher. Length 8–15 mm., ovipositor from ½–⅓ longer than abdomen, black and reddish. Widely distributed throughout the United States and Canada and recorded in Idaho, Oregon, and British Columbia in the west. Parasitic on *Dicerca divaricata* (Say), *Dicerca* spp., *Leptura* spp., and *Serropalpus* spp.

Polysphincta kœbelei Howard. Length 8 mm., black with paler markings and the mesothorax largely reddish, cocoon loose net-like, pinkish brown, 7 x 3 mm. Parasitic on spider, *Epeira* sp., in California and Kansas.

Polysphincta texana Cresson (*P. vicina* Prov., *P. bicarinata* Davis). Length 12 mm., ovipositor very short, black with reddish and white markings. Parasitic on spiders in various parts of the United States and known in Colorado, New Mexico, California, and British Columbia in the west.

Colpomeria kincaidi (Ashmead) (*Zaglyptus*). Length 7 mm., polished black with

white markings, legs black and reddish yellow. Parasitic on spider, *Tetragnathus* sp. in Washington and also reported in New Hampshire.

Megarhyssa nortoni (Cresson) (*Rhyssa*) (Fig. 664). Length 25–38 mm., ovipositor 50–76 mm., black marked with red and spotted yellow, and legs mostly yellow. A large conspicuous parasite occurring throughout boreal North America and recorded in the high mountains of California, Colorado, Utah, Nevada, Oregon, Washington, British Columbia, and Alaska in the west. Parasitic on *Xeris morrisoni* (Cresson), *Sirex* spp., and other *Siricidæ* in living or dead coniferous trees, logs, and stumps. The eggs are laid in the burrows of the host. The eastern *Megarhyssa lunator* (Fabr.), which is parasitic on the immature stages of *Tremex columba* (Linn.), ranges west into Colorado.

Members of the genus *Rhyssa* are also large, varying from 18–30 mm. in length, and parasitic on *Siricidæ*. The four American species all occur in the west and are separated by Rohwer's table [1] as follows:

Table to the Species

1. General color ferruginous; stigma yellow; wings pale brownish with a darker cloud along radius. . . . . *hoferi* Rohwer
   General color black; stigma black; wings uniformly hyaline or subhyaline. 2

2. Posterior orbits black, immaculate, antennæ black. . . . . *alaskensis* Ashmead
   Posterior orbits marked with yellow. 3

3. Antennæ black. . . . . *persuasoria* (Linnæus)
   Antennæ with a pale annulus. . . . . *lineolata* (Kirby)

Rhyssa alaskensis Ashmead (*R. skinneri* Vier.) is recorded in the high mountains of New Mexico, California, Nevada, Idaho, Washington, Alaska, and probably occurs in the other States as well. *Rhyssa hoferi* Rohwer is recorded only from Colorado.

Rhyssa lineolata (Kirby) (*Cryptocentrum lineolatum* Kirby, *Rhyssa albomaculata* Cress., *Epirhyssa crevieri* Prov., *Megarhyssa nitida* Merrill) ranges throughout borlea North America and is recorded in Colorado, Washington, and British Columbia in the west.

Rhyssa persuasoria (Linn.) (*Ichneumon*) occurs throughout boreal North America and is known in Colorado, Utah, and California in the west.

Calliephialtes messor (Gravenhorst) (*Ephialtes*) [2] (Fig. 665). Length 10–12 mm.; ovipositor as long as the body; black with reddish or yellowish legs and yellow body markings; eggs white, long, and slender, pointed at one end, 1.5 mm. long; larvæ white, yellowish, or pinkish and 8 mm. long. This insect is commonly known as the codling moth parasite. It was introduced into California from Spain by the State Commissioner of Horticulture in 1904,[3] to prey on the codling moth, *Carpocapsa pomonella* (Linn.). It works perfectly in confinement, the eggs being laid in the cocoons. The larvæ feed externally upon the caterpillars. In the orchards, however, the parasite soon dies off and is of no value whatever. Pupation occurs in a thin yellowish brown cocoon within the cocoon of the host.

Calliephialtes thurberiæ Cushman. Length 9 mm., ovipositor 8 mm., black with reddish markings. Parasitic on the larvæ of *Anthonomus grandis* Boh. var. *thurberiæ* Pierce in Arizona.

Scambus ephialtoides (Cushman). Length 9 mm., ovipositor 9 mm., color black and rufous. Parasitic on *Barbara colfaxiana* (Kearfott) var. *siskiyouana* (Kearfott) in Montana, Oregon, and California.

Epiurus euuræ (Ashmead) (*Pimpla*). Length 6 mm., black with reddish legs. Reared by writer from galls of *Pontania californica* Marlatt at Berkeley, California.

Epiurus innominatus (Viereck). Length 7.5 mm., black and reddish brown. Parasitic on *Harmologa fumiferana* (Clem.) in British Columbia.

[1] S. A. Rohwer, *Proc. U. S. Nat. Mus.*, 57, p. 419, 1921.

[2] This species has also been referred to two other species, which according to R. A. Cushman are *Calliephialtes comstocki* (Cress.) and *C. pusio* (Walsh). *Jour. Agr. Research*, 1, pp. 211–237, 1913.

[3] Elwood Cooper, *Second Bien. Rept. Comm. Hort. Calif.* 1905–1906, pp. 231–235, 1907.

H. S. Smith and E. J. Vosler, *Mthly. Bul.*, Cal. State Com. Hort. 3, pp. 195–211, 1914.

Epiurus indagator (Walsh) (*Pimpla indagatrix* Walsh).[1] Length 4 mm., shining black, legs whitish, yellow, and black, abdomen sometimes brown or dusky at base. Parasitic on *Archips argyrospila* Walker in Colorado and New Mexico. This parasite ranges throughout boreal North America from the Atlantic westward into British Columbia.

Epiurus pterophoræ (Ashmead) (*Limneria*). Reared from *Ametastegia glabrata* (Fallén) in Washington by E. J. Newcomer.

Tromatobia rufopectus (Cresson) (*Pimpla*). Length 8–10 mm., shining black with reddish legs. Common throughout the United States. Larvæ feed on the eggs of spiders belonging to the family *Epeiridæ*. Reared in large numbers from webbed egg sacs of spiders in Alameda County, California, by the writer and also reported from the eggs of the silver spider, *Argiope argentata* (Fabr.) in Southern California.

Iseropus cœlebs (Walsh)[2] [*Pimpla, Iseropus orgyiæ* (Ashm.)]. Length 7–10 mm., black with reddish legs banded black on the tibiæ and tarsi as in *Ephialtes æqualis* (Provancher). A very common and important parasite throughout boreal North America and abundant in California, Idaho, other Western States, and British Columbia. Parasitic on *Malacosoma americana* (Fabr.), *M. disstria* Hbn., *M. constricta* (Stretch), *M. californica* (Pack.), *Hemerocampa vetusta* (Bdv.), *H. leucostigma* (A. & S.), *H. gulosa* Hy. Edw., *Harmologa fumiferana* (Clemens), in the west, and many other *Lepidoptera* in the east. It is parasitized by *Dibrachys boucheanus* (Ratz.), *Hemiteles thyridopterigis* Riley, and *Pleurotropis albitarsis* Ashm. The last three may also act as tertiary parasites. The variety *bruneifrons* (Viereck) (*Pimpla bruneifrons* Vier.) is very close to the preceding species and is parasitic on *Hemerocampa oslari* (Barnes) in California.

FIG. 665.—Larvæ of the codling moth parasite, *Calliephialtes messor* (Grav.), feeding upon the larvæ of the codling moth within the cocoons of the latter. Portions of the cocoon were removed to expose the host and parasite. (After Smith and Vosler.)

Ephialtes æqualis (Provancher) [*Scambus marginatus* (Prov.)]. Length 14–16 mm., black with pale whitish markings and complete black bands on the tibiæ and tarsi which are otherwise pale reddish. It is a widely distributed parasite on *Carpocapsa pomonella* (Linn.), *Datana ministra* (Drury), *Hemerocampa leucostigma* (A. & S.), and other *Lepidoptera*. It is recorded in Colorado and California in the west.

Ephialtes ellopiæ (Harrington) (*Pimpla*). Length 9.5–13 mm., ovipositor half as long as the abdomen, reddish or partly black. Parasitic on *Ellopia somniaria* Hulst in British Columbia. The parasite also ranges south into Central California.

Ephialtes pedalis (Cresson) (*Pimpla, Scambus*). Length 7.5–16 mm., shining black. Occurs throughout boreal North America and recorded in Colorado, New Mexico, California, Washington, and British Columbia in the west. Parasitic on *Cirphis unipuncta* (Haw.), *Notolophus antiqua*, (Linn.), *Malacosoma disstria* Hbn., *Harmologa fumiferana* (Clem.), *Archips argyrospila* Walker, and other *Lepidoptera*.

Ephialtes sanguinipes[3] (Cresson) (*Pimpla, P. erythropus* Vier.). Length 5–14 mm., black with bright red legs. A western species which is parasitic on *Diacrisia virginica* (Fabr.) and *Lycophotia margaritosa* (Haw.) in Colorado; on *Hemileuca maia* Drury, *H. oliviæ* Ckll., and *Malacosoma fragilis* (Stretch) in New Mexico; and on *Sabulodes*

[1] According to R. A. Cushman this is not a synonym of the European *Scambus detritus* (Holmg.).

[2] R. A. Cushman, *Proc. Ent. Soc. Wash.*, 20, pp. 10–12, 1918.

[3] Commonly wrongly spelled *sanguineipes*.

forficaria Gn. var. *catenulata* (Grote) and *Hemerocampa oslari* (Barnes), in California. J. F. Lamiman has reared many adults from the pupæ of *Carpocapsa pomonella* (Linn.) in California. It is in turn parasitized by the secondary, *Dibrachys boucheanus* (Ratz.), in California.

Itoplectis atrocoxalis (Cresson) (*Pimpla, Exochus*).[1] Length 5–14 mm., black legs, excepting the coxæ, reddish. Reported in New Mexico, Colorado, Utah, Nevada, California and British Columbia. Parasitic on *Malacosoma fragilis* (Stretch) and *Autographa californica* (Speyer).

Itoplectis behrensi (Cresson) (*Pimpla, Pimplidea*) (Figs. 654, 666). Length 7.5–10.5 mm., black, the legs except the coxæ and the sides of the abdomen reddish and the

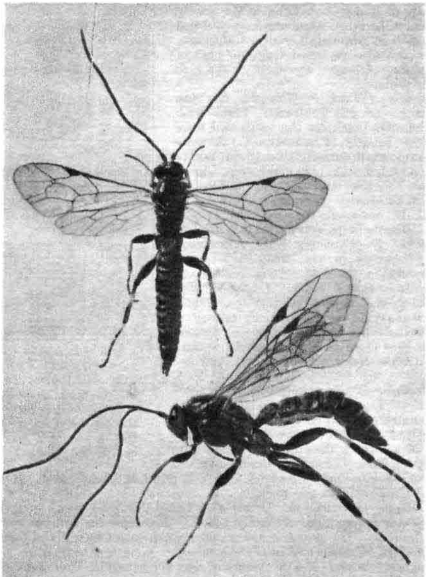

FIG. 666.—The California oak moth parasite, *Itoplectis behrensi* (Cresson).

tergites narrowly yellow on the posterior margins. A very common and effective parasite of *Phryganidia californica* Pack. in California. It is checked by the secondary *Ænoplex phryganidiæ* (Ashm.).

Itoplectis conquisitor (Say) (*Cryptus, Pimpla, Scambus*). Length 5.5–15 mm., variable in color, black with reddish legs and banded tarsi, and the abdominal segments with pale posterior marginal borders. Both a primary and secondary parasite. The adults

[1] R. A. Cushman, "The Tribe *Ephialtini*." *Proc. U. S. Nat. Mus.*, 58, pp. 327–362, 1920.

oviposit in the larvæ and newly formed pupæ and frequently feed on the juices exuding from the egg punctures. Primary on *Hemileuca oliviæ* Ckll., *Autographa brassicæ* (Riley), *Alabama argillacea* Hbn., *Hemerocampa leucostigma* (A. & S.), *Malacosoma californica* (Pack.), *M. disstria* Hbn., *Archips argyrospila* Walker, *A. cerasivorana* (Fitch), *Harmologa fumiferana* (Clemens), and also many other *Lepidoptera* in the Eastern States. Secondary on *Hyposoter fugitivus* (Say), *Rogas* (*Alieodes*) *intermedius* (Cress.), *Agrothereutes extrematis* Cress., etc.

Itoplectis evetriæ (Viereck) (*I. plesia* Rohwer). Length 6–10 mm., black with legs blackish and reddish. Parasitic on *Pinipestis cambiicola* Dyar and *P. zimmermani* (Grote) in Montana; on *Barbara* sp. in California; and on *B. colfaxiana* (Kearfott) and the var. *siskiyouana* (Kearfott) in Oregon.

Itoplectis obesus (Cushman). Length 8 mm., ovipositor 1.5 mm., stout, black and reddish. Reared from *Archips argyrospila* Walker and *Spilonota ocellana* (D. & S.) in Washington and from *Harmologa fumiferana* (Clemens) in British Columbia. It also occurs in California.

Itoplectis esuchus Cushman.[1] Length 7.5 mm., ovipositor 1.4 mm., similar to preceding species in color. Parasitic on *Carpocapsa pomonella* (Linn.) and on *Euceratia castella* Wlshm. in the San Francisco Bay region, California. It also occurs in British Columbia.

Theronia atalantæ (Poda) var. *fulvescens* (Cresson) (*Pimpla fulvescens* Cresson). Length 7–15 mm., amber yellow. Probably a secondary parasite through *Iseropus cœlebs* (Walsh), *Itoplectis conquisitor* (Say), and *Ephialtes pedalis* (Cresson), on *Hemerocampa* spp., *Malacosoma* spp., *Harmologa fumiferana* (Clem.), and other *Lepidoptera* throughout various parts of the country. The writer has made many rearings in California. It is also recorded in New Mexico, Arizona, Colorado, Oregon, Washington, and British Columbia in the west.

Apechthis pacificus Cushman. Length 12 mm., ovipositor 2 mm., black, hind and middle tibiæ black with white rings, front coxæ tricolored. Parasitic on *Notolophus antiqua* (Linn.) in Oregon.

Apechthis ontario (Cresson) (*Pimpla*). Length 7–12 mm. Parasitic on *Harmologa fumiferana* (Clemens) in the east and on *Tortricidæ* in California, Washington, Idaho, and British Columbia.

Itamoplex tejonensis (Cresson) (*Cryptus*). Length 10–18 mm., black, the legs and abdomen entirely reddish. Parasitic on the larvæ and pupæ of *Ægeria opalescens* Hy. Edw., in Oregon.[2] It also occurs in California.

Cænocryptus newcomeri Cushman. Length 9–10 mm., antennæ 7–8 mm., ovipositor 2 mm., black, first four or five abdominal segments and legs reddish. Parasitic on *Ametastegia glabrata* (Fallén) in Washington.

Cryptohelcostizus alamedensis (Ashm.) (*C. rufigaster* Cushman). Length 11 mm., ovipositor 3 mm., black, the abdomen and legs mostly reddish. Parasitic on *Chrysobothris mali* Horn and *Agrilus angelicus* Horn in California.

Chæretymma minuta Cushman. Length 4.5–6 mm., antennæ 3–4 mm., ovipositor 2 mm., black, legs testaceous. Parasitic on *Ametastegia glabrata* (Fallén) in Washington.

Pezoporus osculatus (Provancher) (*Cryptus*, *Microcryptus*). Length 6.5–8.5 mm., ovipositor more than half as long as the abdomen. Parasitic on *Ametastegia glabrata* (Fallén) in Washington.

Phygadeuon epochræ Viereck. Length 3 mm., black, portions of the legs and the base of the abdomen brown. Parasitic on *Epochra canadensis* (Loew) in Montana.

Panargyrops tibialis (Cushman) (*Bathythrix*). Length 7 mm., ovipositor 3 mm., black with white and reddish markings. Probably a secondary parasite, having been reared from *Ametastegia glabrata* (Fallén) in Washington.

Ænoplex phryganidiæ (Ashmead) (*Phygadeuon*). Length 5 mm., head and thorax black, abdomen and legs rufous. Secondary parasite on *Itoplectis behrensi* (Cresson), on *Phryganidia californica* Pack. in California.

Ænoplex plesiotypus Cushman. Length 5.5 mm., black with white and reddish

[1] This species was described as *Ephialtes pacificus* Cushman, but as that name was preoccupied by *Ephialtes pacificus* Harrington, it was recently changed to the above. *E. pacificus* Harrington is 20–25 mm. long; black and rufous in color; and occurs in British Columbia.

[2] F. H. Lathrop and A. B. Black, *Third Crop Pest and Hort. Rept.* 1915–1920. Ore. Agr. Exp. Sta., p. 63, 1921.

markings. Reared from chrysalis of *Carpocapsa pomonella* (Linn.) in Southern California. It is in turn parasitized by *Dibrachys boucheanus* (Ratz.).

Ænoplex nigrosoma Cushman. Length 7.5 mm., ovipositor 3.5 mm., black with reddish legs. Reared from *Ametastegia glabrata* (Fallén) in Washington by E. J. Newcomer along with all the other parasites listed from this host.

Ænoplegimorpha micator (Gravenhorst) (*A. phytonomi* Vier.). Length 4.5 mm., shining black, legs yellow and reddish, base and venter of the abdomen reddish. Reared from *Phytonomus posticus* (Gyll.) in Utah.

Chrysopoctonus patruelis Cushman. Length 4 mm., antennæ 3 mm., ovipositor 0.8 mm., black, the entire prothorax, part of mesothorax, base and margins of the tergites of the abdomen, and the legs reddish. Parasitic on *Chrysopa californica* Coq. in Southern California.

Hemiteles areator (Panzer) subspecies *tenellus* (Say) (*H. utilis* Norton) (Fig. 667). Length 8 mm., brown or blackish with two conspicuous dusky bands across each front wing, cocoon regularly oval-cylindrical, felty white with brown or dusky markings.

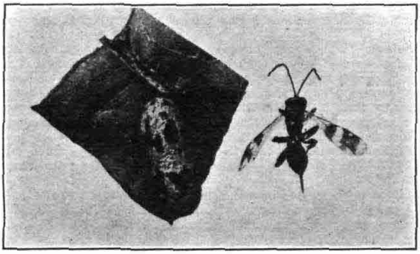

FIG. 667.—Cocoon and adult of *Hemiteles areator* (Panzer) subsp. *tenellus* (Say).

A secondary parasite on many of the important primary parasites of *Lepidoptera* throughout the entire country. It has been frequently reared from *Schizura concinna* (A. & S.), through *Hyposoter fugitivus* (Say) *pacificus* Cushm., and also from *Sabulodes caberata* Guenée, through *Ophion* spp., by the writer, in California.

Amblyteles astutus (Holmgren) (*Ichneumon*). Length 8 mm., reddish with dusky areas. Reared from pupæ of *Ochlodes sylvanoides* (Bdv.) in Southern California by the writer.

Amblyteles subfuscus Cresson. Length 12 mm., reddish brown with or without black bands on basal abdominal segments. Reared from *Chorizagrotis auxiliaris* (Grote) and *Euxoa excellens* (Grote), and occurs in Colorado, Nevada, California, and British Columbia.

Ichneumon occidentalis (Cresson) (*Ephialtes*). Length 20–28 mm., very slender, black species with ovipositor longer than the body. The species of *Ichneumon* are parasitic on the larvæ of the wood-boring *Coleoptera* (R. A. Cushman).

CYNIPOIDEA[1] (Superfamily)

Small gall-making, parasitic and guest or inquilinous insects

KEY TO FAMILIES [2]

1. Dorsal abdominal segments not extending down along the sides so as to meet beneath ventral segments, therefore all or nearly all of the ventral segments visible 2

[1] W. H. Ashmead, "Classification of *Cynipoidea*." *Psyche*, 10, pp. 7, 59, 140, 1903.
[2] From *Hym. of Conn.* Bul. 22, *Conn. Geol. and Nat. Hist. Surv.*, pp. 361–362, 1916.

Dorsal abdominal segments extending down along the sides and meeting beneath, thereby completely enclosing or concealing the ventral segments or all of the ventral segments except a part of the apical one or the hypopygium .... **Figitidæ** p. 812

2. Basal joint of hind tarsi usually shorter and never much longer than joints two to five united; abdomen not at all or very little longer than head and thorax combined .... **Cynipidæ**
   Basal joint of hind tarsi at least twice as long as second, third, fourth, and fifth joints united; second, third, and fourth joints of tarsi longer than fifth, second with a long spinous process extending outwardly; abdomen very distinctly compressed from side to side, spatulate, and distinctly longer than head and thorax united; first to fourth or even including fifth segment nearly equal in length to each other .... **Ibaliidæ** p. 812

CYNIPIDÆ.[1] Gallflies.

Members of this family are small winged, sober colored, mostly black, reddish brown, or yellowish, wasp-like or ant-like insects. The adults

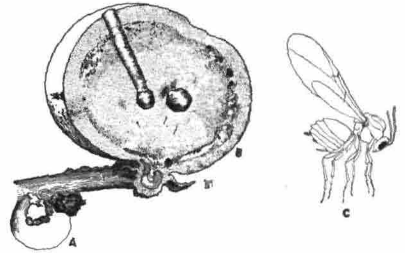

FIG. 668.—The California gallfly, *Andricus californicus* (Bassett). A, small immature gall; B, mature gall showing larval cells and exit hole of adult; C, adult female.

are bisexual or agamic and many have alternate fall agamic generations. They appear in the fall or the spring and the eggs are deposited in the dor-

[1] C. R. Osten Sacken, "Contrib. to Nat. Hist. of *Cynipidæ* of U. S." *Trans. Am. Ent. Soc.*, 3, p. 54. 1870.
H. F. Bassett, "N. A. *Cynipidæ*." *Can. Ent.*, 13, p. 51, 1881. *Trans. Am. Ent. Soc.*, 17, p. 59, 1890; 26, p. 310, 1900.
W. H. Ashmead, "Cat. N. A. *Cynipidæ*." *Trans. Am. Ent. Soc.*, 12, p. 291, 1885. "Synopsis of N. A. Subfamilies of *Cynipidæ*." *Trans. Am. Ent. Soc.*, 13, p. 59, 1886.
C. P. Gillette, "Colorado *Cynipidæ*." *Ent. News*, 3, p. 246, 1892. "New *Cynipidæ*." *Can. Ent.*, 25, p. 110, 1893; 26, p. 234, 1894. "Mon. Genus *Synergus*." *Trans. Am. Ent. Soc.*, 23, p. 85, 1896.
C. F. Baker, "New Am. Parasitic *Cynipidæ*." *Can. Ent.*, 28, p. 131, 1896.
K. W. von Dalla Torre and J. J. Kieffer, "*Cynipidæ*." *Genera Insectorum, Fasc.* 9, 10, 1902.
Wm. Beutenmüller, "New Species of *Cynipidæ*." *Ent. News*, 22, p. 67, 1911; 29, p. 251, 1918. "N. A. Acorn Galls." *Bul. Brooklyn Ent. Soc.*, 8, p. 101, 1913. "New *Cynipidæ*." *Can. Ent.*, 43, p. 211, 1911; 45, p. 280, 1913; 49, p. 345, 1917; 50, p. 305, 1918.
D. T. Fullaway, "Mon. of the Gall-making *Cynipidæ* of California," *Ann. Ent. Soc. Am.*, 4, p. 331, 1911.
Lewis H. Weld, "A New Oak Gall from Arizona." *Can. Ent.*, 51, p. 254, 1919. Ameri-

mant or developing buds, leaves, stems, or roots of the host plants which are chiefly oak trees. The developing small, legless larvæ cause deformations known as galls which are in reality food and living chambers where

FIG. 669.—The woolly galls of the ant-like gallfly, *Andricus lasius* (Ashm.), on canyon live oak.

the larval and pupal development occur. Each gall is inhabited by a single individual (monothalamous), by two (bithalamous), or by many (polythalamous). Characteristic galls are produced by the different species and

can Gallflies of the Family *Cynipidæ* Producing Subterranean Galls on Oak." *Proc. U. S. Nat. Mus.*, 59, p. 187, 1921. "Notes on Certain Genera of Parasitic *Cynipidæ* Proposed by Ashmead, with Descriptions of Genotypes." *Ibid.*, p. 433. "Notes on Cynipid Wasps, with Descriptions of New N. A. Species." *Ibid.*, 61, p. 1, 1922. "Notes on Am. Gallflies of the Family *Cynipidæ* Producing Galls on Acorns, with Descriptions of New Species." *Ibid.*, 61, p. 19, 1922.

A. C. Kinsey, "New Species and Synonymy of Am. *Cynipidæ*." *Bul. Am. Mus. Nat. Hist.*, 42, p. 293, 1920. "Life Histories of Am. *Cynipidæ*." *Ibid.*, p. 319. "Phylogeny

even the varieties may cause certain fixed forms which greatly aid in classification. The galls remain fixed on the stems and roots or are deciduous and fall to the ground during the late summer and autumn. The winter is spent as larvæ or adults in the galls on the tree or in the galls which fall to the ground. Inquilines or guest wasps often occur in the same galls and are believed to assist or interfere in the formation of these objects. These insects belong to the same family and are all truly bisexual. Parasites and many other insects also invade the galls.

There are over two hundred species of gallflies in the western United States, of which only a few of the most abundant and widely distributed ones are included in this work.

The California gallfly, *Andricus californicus* (Bassett) (Figs. 604, 668), produces the largest and best known gall in the west. The adults are

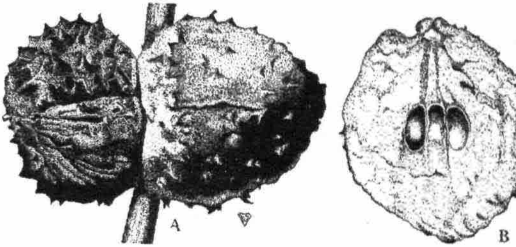

FIG. 670.—Galls of the live oak gallfly, *Andricus pomiformis* (Bassett), on coast live oak. A, galls on twig; B, cross section to show larval cells.

brownish or reddish brown and 3–5 mm. long. They emerge from October in the north to February in the far south. The galls begin to form on the twigs in the spring and are globose or reniform, at first green often with a red side, and are frequently called oak apples. They later become tan, whitish, or very dark with age. The average size approximates 40–100 mm. From a few to many larvæ inhabit the galls. The hosts are valley, blue, scrub and leather oaks. The range is from Lower California along the Pacific Coast into Washington. Kinsey recognizes four varieties, *californicus* (Bassett), *spongiolus* (Gillette), *fructiformis* Kinsey, and *intermedius* Kinsey. The large galls are also inhabited by many other insects.

The ant-like gallfly, *Andricus lasius* (Ashmead) (*Callirhytis*) (Fig. 669), is 2–2.5 mm. long and pale and dark rufous. The galls are subglobular or globular, woody, thickly

of Cynipid Genera and Biological Characteristics." *Ibid.*, p. 357. "New Pacific Coast *Cynipidæ*." *Ibid.*, 46, p. 279, 1922. "Studies of Some New and Described *Cynipidæ*." *Ind. Univ. Studies*, 9, No. 53, 1922. "Varieties of a Rose Gall Wasp." *Ibid.*, p. 142 (with K. D. Ayres). "The Gall Wasp Genus *Neuroterus*." *Ind. Univ. Studies*, 10, No. 58, p. 97, 1923.

I. McCracken and D. Egbert, "California Gall-making *Cynipidæ*, with Descriptions of New Species." *Stanford Univ. Pub. Univ. Ser., Biol. Sci.*, 3, No. 1, 1922.

The writer is indebted to Dr. A. C. Kinsey for many suggestions and corrections in the manuscript dealing with this family.

covered with whitish, yellowish, reddish, or dusky woolly filaments, are 5–7 mm. in diameter, and attached to the midrib or petiole of the leaves of canyon, live, or maul oak. They are inhabited by several or many larvæ from which the parasite, *Syntomaspis californica* Ashmead, has been reared. The species occurs throughout California. The varieties *lasius* (Ashm.), *sublasius* Kinsey, and *areolaris* Kinsey, occur in various parts of the State, all of which produce similar galls.

FIG. 671.—Galls of *Andricus bicornis* (McC. and Egbert), on underside of leaf of coast live oak. The epidermis was eaten away by the caterpillars of the oak ribbed case maker, *Bucculatrix albertiella* Busck.

The live oak gallfly, *Andricus pomiformis* (Bassett) (*Callirhytis*) (Fig. 670), is 3–4 mm. long, has the head and thorax wholly black and coarsely sculptured, and the abdomen rufous to black and shining. It produces large globular or subglobular, solid, smooth, or roughened galls much like those of *A. californicus* (Bassett). The hard larval cells are near the base. The galls are attached to the twigs of the coast live oak and interior live oak in California. The varieties *pomiformis* (Bassett), *maculipennis* (Kieffer), *distinctus* Kinsey, *provincialis* Kinsey, and *descansonis* Kinsey, all form smooth or somewhat ridged galls, excepting *distinctus* Kinsey, which makes roughened or filamentose galls. The inquilines, *Synergus splendidus* Fullaway, *S. ochreus* Fullaway, *S. flavus* Kieffer, *S. varicolor* Fullaway, and *Ceroptres pomiformis* Ashmead, have been reared from these galls. *A. brunneus* Fullaway forms thin-walled, brownish, monothalamous galls 3 mm. in diameter on the undersides of the leaves of blue oak throughout central California. *A. castanopsidis* Beutenmüller forms smooth green and reddish or brown, globular, thin-walled, monothalamous galls 11–25 mm. in diameter on the staminate blossoms of the western and bush chinquapins in many parts of California. The guest, *Periclistus castanopsidis* Beutenmüller, has been taken in the galls on western chinquapin at Truckee, California. *A. confertus* McCracken and Egbert is dark brown, 2.5 mm. long, and produces rounded, pinkish, closely massed, monothalamous galls on the midribs and veins on the undersides of the leaves of the valley oak throughout central California. The inquiline, *Synergus confertus* McCracken and Egbert also inhabits the same galls. The guest, *Periclistus confertus* McC. & Egb., also occurs in the same galls. *Andricus bicornis* (McCracken and Egbert) (*Callirhytis*)[1] (Fig. 671) is yellowish-brown and dusky and 1.5 mm. long. It produces very characteristic oval or subglobular, thin-walled, monothalamous galls 2–4 mm. long which have each end drawn out into a point or horn and vary from green to yellow, purplish, or brown. They are borne in large numbers on the veins of the undersides of the leaves of the coast live oak throughout Central and Southern California. The galls drop when mature. The presence of the galls on the leaves causes a yellowing of the foliage and somewhat disfigures the trees. *Andricus agrifoliæ* (Bassett) (*Cynips, Callirhytis*)

[1] Most species of this old genus fall into other genera.

(Fig. 672) produces small, marble-like, corky, monothalamous galls 10 mm. in diameter which are at first green with reddish and brown mottlings, turning brown or dark, and attached to the axils of twigs or leaves of the coast live oak throughout the coastal region of California. *Andricus crystallinus* Bassett forms beautiful, palisadal, bright red galls, 8 or 9 x 3 or 4 mm., which are covered with crystalline filaments and are clustered on the undersides of the leaves of scrub, blue, leather, and valley oaks in California, Oregon, and Washington. *A. eldoradensis* Beutenmüller is pale brownish, 2.5 mm. long, and makes rounded larval cells which often completely fill the insides of

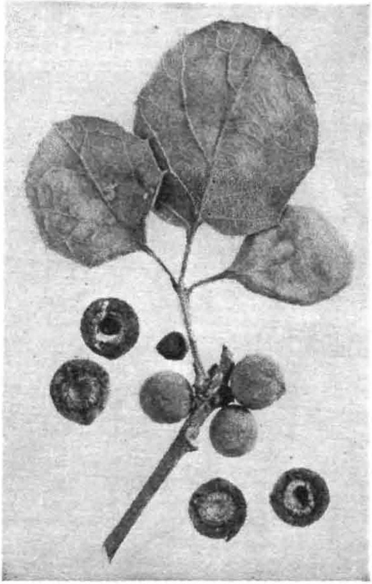

FIG. 672.—Galls of *Andricus agrifoliæ* (Bassett) on coast live oak.

acorns of the coast live oak throughout California. *A. fullawayi* Beutenmüller produces elliptical, brown, thin-walled monothalamous galls which have the surface reticulate and covered with brown fibres and are 0.5 mm. in diameter. They occur along the midrib of the leaves of valley oak and white oaks throughout the entire western area. *A. kingi* Bassett (Fig. 673) produces somewhat conical yellow, pink, and reddish thin-walled, monothalamous galls on the undersides of the leaves of blue oak, Oregon oak, and valley oak throughout the Pacific Coast States. The bases of the galls are saucer-shaped and the apex is opened. The larval cell lies at the base which is attached by a very small stalk. *A. parmula* Bassett makes small, disc-shaped, reddish or brownish monothalamous galls 2–3 mm. in diameter on the undersides and, rarely, on the upper-sides of the leaves of blue, leather, Oregon, and valley oaks throughout the Pacific Coast

States. *A. pattersonæ* Fullaway (Fig. 674) causes thin disc-like green or brown monothalamous galls 5–6 mm. in diameter on the undersides of the leaves of blue oak throughout California. *A. pedicellatus* Kinsey produces small elongated monothalamous galls 1–1.5 mm. x 5–7 mm., which are attached by a slender thread near the edges of the young leaves of blue oak throughout central and northern California. *A. reniformis* McCracken and Egbert, is black and reddish and 3 mm. long. It produces kidney-shaped yellowish, green, or tan polythalamous bud galls 5–25 mm. long, on huckleberry oak in the Lake Tahoe region, California. The inquiline, *Synergus reniformis* McCracken and Egbert, also inhabits the galls. *A. spectabilis* Kinsey is black and 3.7–4.7 mm. long. It produces hard spindle-shaped swellings 25 x 100 mm. on the twigs of the canyon live or maul oak throughout California. The variety *spectabilis* (Kinsey) occurs in the Sierras of central and southern California, the var. *incisus* Kinsey in the Sierras of central and northern California, and the var. *ukiahensis* Kinsey along the northern coast of California. *A. wiltzæ* Fullaway forms bud galls in the axils of the leaves, which are covered with a mass of abortive leaves. It is polythalamous and occurs on valley oak throughout central California. *A. yosemite* Beutenmüller produces nearly globular spiny and wrinkly, yellowish brown and pink, pulpy, polythalamous galls 20 mm. in diameter and with an apical nipple on the twigs of canyon live or maul oak in the Yosemite Valley, California.

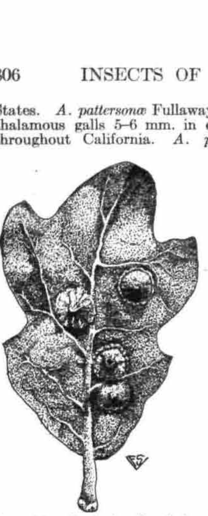

FIG. 673.—Conical galls of *Andricus kingi* Bassett on blue oak.

Compsodryoxenus brunneus Ashmead is brownish rufous and 1.7–3 mm. long. It lives in the young stems of white oak in California. The cells are 1 x 2.5 mm. and do or do not cause a slight swelling of the twigs. The variety *brunneus* (Ashm.) occurs on canyon live or maul oak wherever this tree occurs in the State, and the var. *atrior* Kinsey occurs on valley oak throughout the State.

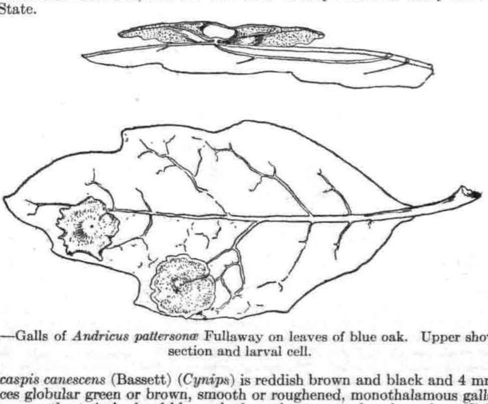

FIG. 674.—Galls of *Andricus pattersonæ* Fullaway on leaves of blue oak. Upper shows cross section and larval cell.

Disholcaspis canescens (Bassett) (*Cynips*) is reddish brown and black and 4 mm. long. It produces globular green or brown, smooth or roughened, monothalamous galls in the leaf axils or on the twig buds of blue oak throughout central and northern California.

D. corallina (Bassett) (*Cynips*) produces pale yellow or reddish spherical monothalamous galls which are 12 mm. in diameter and covered with irregular coral-like tubercles. They occur on the twigs and in the leaf axils of blue oak in the San Francisco Bay region, California, and also in Utah. The parasite, *Syntomaspis californica* Ashm., has been reared in large numbers from the galls by the writer. *D. washingtonensis* (Gillette) produces ellipsoid swellings 5–7 mm. long, brown and monothalamous on the sides of small twigs of Oregon oak in Oregon and Washington. McCracken and Egbert report galls on leather oak, scrub oak, and valley oak in Santa Clara County, California, and Kinsey records galls on blue oak in California.

Cynips maculipennis (Gillette) (Fig. 675) produces beautiful, spherical, smooth, green or yellowish, mottled with red, thin-walled galls 15–30 mm. in diameter. The single larval cell is held in the centre by numerous fine radiating fibres. The galls are

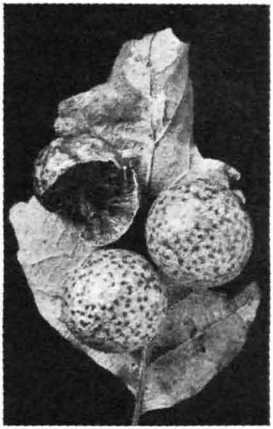

FIG. 675.—Galls of *Cynips maculipennis* (Gillette) on leaf of Oregon oak.

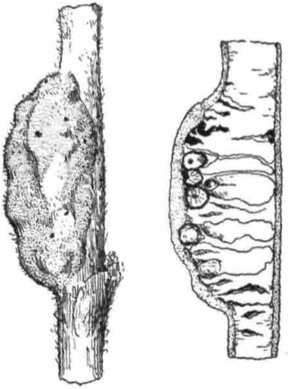

FIG. 676.—Stem galls of the thimbleberry gallfly, *Diastrophus kincaidi* Gillette, on thimbleberry. Cross section at right to show larval cells.

borne on the upper sides of the leaves of Oregon or garry oak in northern California and Oregon and on Wright's oak in New Mexico. *C. mirabilis* Kinsey produces a similar gall on Oregon oak in California, Oregon, Washington, and British Columbia.

The thimbleberry gallfly, *Diastrophus kincaidi* Gillette (Fig. 676), is black with rufous legs and 2–2.5 mm. long. The larvæ produce large conspicuous, irregular polythalamous galls as large as 20 x 60 mm. in size on the stems of thimbleberry in California, Oregon, Washington, Idaho, and British Columbia. The variety *kincaidi* (Gillette) occurs north, while the variety *austrior* Kinsey is common in California.

Diplolepis bassetti (Beutenmüller) (*Rhodites*), is black with reddish legs and 2–3.2 mm. long. It forms mossy green or reddish polythalamous galls terminally on the twigs of wild rose in Utah, Idaho, and Oregon. The variety *bassetti* (Beutenmüller) occurs at Corvallis and Ashland, Oregon; the variety *lucida* Kinsey, at La Grande, Oregon, and Mountain Home, Idaho. **The rose root gallfly,** *Diplolepis radicum* (Osten Sacken), is blackish with reddish legs and 3–4 mm. in length. It forms large, pithy, irregularly rounded, polythalamous, reddish brown root galls, 70 x 105 mm., on roses in northern parts of the United States, extending west into Washington. The var. *utahensis* (Bassett) occurs in Utah; the var. *plana* Kinsey in Oregon; and the var. *divergens*

Kinsey in Idaho and eastern Washington. *Diplolepis fusiformans* (Ashmead) is black and rufous and 1.5–2.2 mm. long. It produces small, irregular, subglobular, woody, polythalamous galls on the stems of roses throughout North America, west of the 100th meridian. The variety *fusiformans* (Ashm.) occurs in Colorado. The var. *minuta* Kinsey has been taken at Little Bear Lake in the San Bernardino Mountains in Southern California; the var. *mendocinensis* Kinsey occurs in the northern coast counties of California. *Diplolepis politus* (Ashmead) (Fig. 677) produces globular, spiny thin-walled, red and green monothalamous galls, 5–10 mm. in diameter, in clusters on the leaves and stems of the wild rose throughout California and

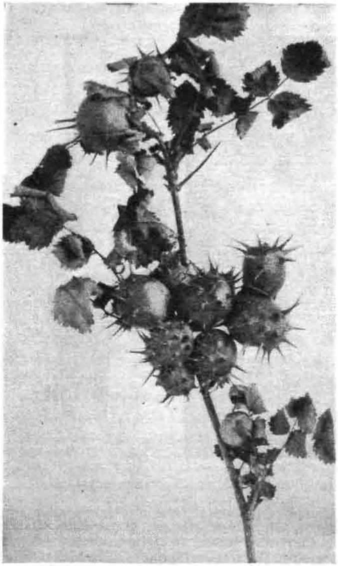

FIG. 677.—Spine galls of *Diplolepis politus* (Ashm.), on the leaves of wild rose.

Oregon, and eastward into Colorado. *D. tuberculatrix* (Cockerell) produces irregularly, rounded, mossy or leafy, polythalamous, terminal or lateral twig galls up to 50 mm. in diameter on roses in many parts of North America, west of the 100th meridian and north into Alaska. The following varieties are recognized by Kinsey and Ayres: *similis* (Ashm.) in Wyoming; *arefacta* (Gill.) in Colorado; *coloradensis* Kinsey and Ayres in Colorado; *tumida* (Bassett) in Utah; *wasatchensis* Kinsey and Ayres in Utah; *californica* (Beutenmüller) in California; *versicolor* Kinsey and Ayres in Oregon; *melanderi* Kinsey and Ayres in Washington; *rubriderma* Kinsey and Ayres in California; *sierranensis* Kinsey and Ayres in the high mountains of California; *descansonis* Kinsey and Ayres in the extreme southern part of California.

Dryophanta echina (Osten Sacken) (*Cynips, Andricus, Diplolepis*) (Fig. 678) is reddish brown and black and 2.5–3 mm. long. It produces characteristic and beautiful echinid galls which are globular, spiny, coral red, monothalamous, 6–12 mm. in diameter, and borne singly or in clusters on the undersides of the leaves of blue oak in the Sierra foothills and the coastal region of middle California. *D. douglasi* (Ashmead) (Fig. 679) produces conspicuous star-shaped pink or coral red galls, often with pale bloom, 8–12 mm. in diameter, and flat above with usually about 8 projections. They are monothalamous and occur singly or in numbers on the undersides of the leaves of valley oak and blue oak in the San Francisco Bay region, California. *D. dubiosa* (Fullaway)

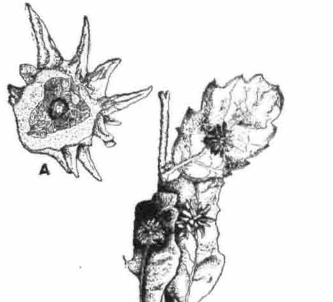

FIG. 678.—Echinid galls of *Dryophanta echina* (O. S.), on leaves of blue oak. A, cross section showing larval cell; B, single gall enlarged.

produces small, brown, irregular, club-shaped, thin-walled, monothalamous galls 3 x 4 mm., in the staminate flowers of coast live oak in the San Francisco Bay region, California. *D. glabra* Gillette forms straw colored or brown subglobular monothalamous galls 4–6 mm. in diameter, along the midribs of the undersides of the leaves of Gambel's oak in Colorado. *D. porteræ* Cockerell produces similarly shaped reddish galls on the leaves of the same host in New Mexico. *D. variabilis* (Bassett) and varieties make conspicuous globular or oval leaf galls on roses in Utah and Colorado.

Disholcaspis chrysolepidis (Beutenmüller) produces small, reddish, woody, cushion-like, sessile, monothalamous galls 3–4 mm. in diameter and 3 mm. high, in clusters on the twigs of canyon live or maul oak in the Sierra foothills of central California. *D. eldoradensis* (Beutenmüller) (Fig. 680) produces similar purplish galls in small rows on the twigs of leather oak, scrub oak, and valley oak from the Sierra foothills to the coast of central California.

Heterœcus dasydactyli (Ashmead) (*Andricus*) is a rich brownish red species 1.7–3.5 mm. long, which produces a woody, spindle-shaped, pale green, monothalamous or rarely bithalamous gall, which is covered with long yellow or buff wool. The galls are alone or in clusters on the twigs of canyon live or maul oak and huckleberry oak through-

out California. The var. *dasydactyli* (Ashm.) occurs in the middle Sierras; the var. *eriophorus* (Kieffer) in the central and southern parts of the State, and the var. *pygmæus* Kinsey in the southern part of the State. *H. pacificus* (Ashmead) (*Andricus*) (Fig. 681) produces spindle-shaped, woody, smooth, green, mottled brown and purple, monothalamous twig galls on the canyon live or maul oak throughout California. The var. *pacificus*

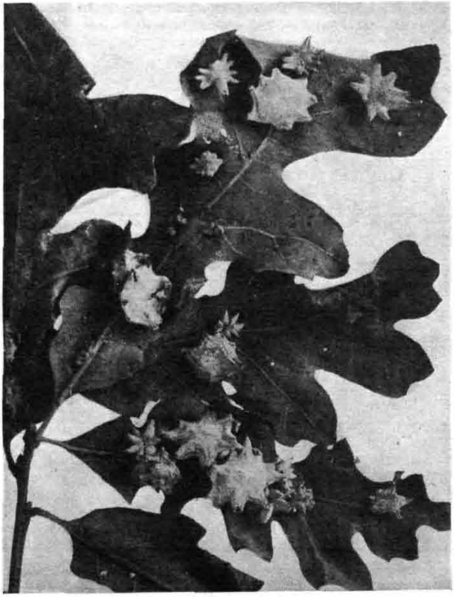

FIG. 679.—Star-like galls of *Dryophanta douglasi* (Ashm.), on leaves of valley oak.

(Ashm.) occurs in the central part of the State; the var. *subpacificus* Kinsey occurs in the Sierras of middle California; and the var. *gracilis* Kinsey, in the northern coast counties. The inquilines, *Synergus pacificus* McCracken and Egbert and *S. nigro-ornatus* McCracken and Egbert, also inhabit the same galls.

The jumping oak galls, produced by *Neuroterus* (*Diplobius*) *saltatorius* (Edwards) (Fig. 682), are minute globular or ovate, seed-like galls 1–2 mm. in diameter, smooth, thin walled, monothalamous, and attached by a point, in great numbers on the undersides of the leaves of various oaks. They drop to the ground when ripe and the larvæ throw themselves within causing the galls to jump a considerable distance probably in an attempt to find lodgment in a crack or crevice for subsequent hibernation and development. They are often so abundant as to cover the ground and jump about with great agility. As a result thousands may be moving at the same time. Galls of this type occur

throughout the country on many kinds of oaks. The adults are black with pale yellowish or brownish legs and antennæ and are 0.6–1 mm. long. The var. *decrescens* Kinsey occurs on Arizona oak in Arizona and in adjacent territory in Mexico; the variety *saltatorius* (Edwards) is very common on valley oak throughout California where it is particularly abundant in the Sacramento Valley, the active little galls being known as flea seeds. *N. decipiens* Kinsey produces similar galls on leather oak, scrub oak, and blue oak in California.

FIG. 680.—Galls of *Disholcaspis eldoradensis* (Beutenmüller), on twig of valley oak.

Plagiotrichus chrysolepidicola (Ashm.) (*Cynips*, *Callirhytis*) (Fig. 683) is rufous, shaded with black, and varies from 1.5–3.5 mm. in length. It produces enlarged twig galls 25–40 mm. in length on all white oaks in California and Oregon. The var. *chrysolepidicola* (Ashm.) is doubtfully recorded from canyon live or maul oak in the San Francisco Bay region, California; the var. *kelloggi* (Fullaway) occurs on blue oak throughout California; the var. *diminuens* Kinsey produces a long slender gall on scrub oak in central and southern California; the var. *alutaceus* Kinsey produces a robust gall 20 x 40 mm. on scrub oak in central and southern California; the var. *atricinctus* Kinsey occurs on blue oak in central and northern California; the var. *compositus* Kinsey on blue oak in the middle Sierras of California; the var. *pungens* Kinsey causes knotted galls on valley oak in the upper San Joaquin Valley, California; the var. *pugnoides* Kinsey causes knotted galls on the valley oak along the coast north of San Francisco Bay, California; the var. *garryanæ* Kinsey causes slender elongate woody galls 14 x 40 mm. on the twigs of Oregon live oak in northern California, Oregon, Washington, and British Columbia. *P. frequens* (Gillette) (*Andricus*) forms dense corky enlargements about $^{2}/_{3}$ x 2 inches on the limbs of undulate oak in Colorado and Utah. *P. perdens* (Kinsey) forms stem galls up to 8 inches in length on black oak and interior

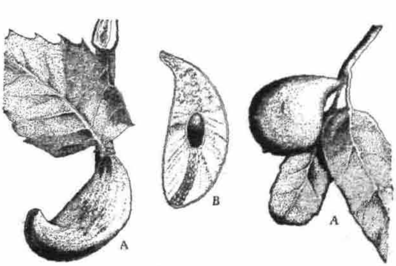

FIG. 681.—Galls of *Heterœcus pacificus* (Ashm.), on canyon live oak. A and B, common forms; C, cross section showing larval cell.

live oak in California and Oregon. Kinsey reports it killing large acreages of these trees *P. suttoni* (Bassett) produces the most conspicuous stem swellings on the twigs of the coast live oak and on black oaks in California, Oregon, Washington, and probably also in British Columbia.

IBALIIDÆ. Large Parasitic Woodwasps.

Ibalia ensiger Norton (Fig. 684) is one of the larger members of the superfamily, measuring 10–15 mm. in length. The abdomen is compressed very thin laterally, the

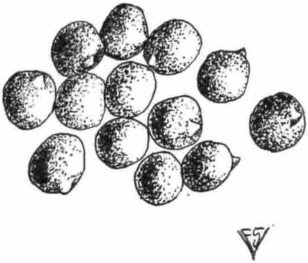

FIG. 682.—Minute jumping galls of *Neuroterus saltatorius* (Edwards), from the leaves of the valley oak.

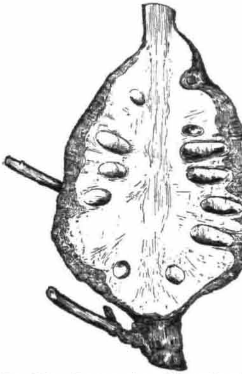

FIG. 683.—Cross section of the twig gall of *Plagiotrichus chrysolepidicola* (Ashm.,) showing the larval cells.

FIG. 684.—*Ibalia ensiger* Norton. A parasitic woodwasp.

body is all black excepting the abdomen which is reddish brown and with the ovipositor of the same color and as long. Adults were taken in considerable numbers by Stanley Flanders ovipositing in Monterey cypress and Monterey pine trees which were infested with the larvæ of *Sirex areolatus* (Cresson) and *S. behrensi* (Cresson), on the campus of the University of California, Berkeley, November 25 and 26, 1922. It is probably also parasitic on other species of *Sirex* and occurs throughout the United States and Canada and in all the western area.

FIGITIDÆ. Figitid Parasites.

The members of the genus *Xystus* (*Allotria*, *Charips*),[1] are minute secondary parasites on certain primary parasites of plant lice or aphis. *X. bakeri* (Kieffer) is 0.5–0.8 mm. long, blackish, with amber antennæ and legs. It has been reared from *Diæretus salicaphis* (Fitch) on *Periphyllus salicicola* (Essig), and from *Lysiphlebus testaceipes* (Cress.) on *Aphis gossipii* Glover, and other aphis in many parts of California. *Xystus brassicæ* (Ashmead) is parasitic on *Lysiphlebus testaceipes* (Cress.) on *Brevicoryne brassicæ* (Linn.), and on other parasites of aphis and occurs throughout the country. *Xystus leguminosa* (Weld) is thought to be parasitic on *Aphelinus lapisligni* Howard, a primary parasite

[1] H. Weld, Key to Species. *Ent. News*, 31, p. 15, 1920.

of *Anuraphis bakeri* (Cowen), in Idaho. *Xystus xanthopsis* (Ashmead) is secondary on *Lysiphlebus testaceipes* (Cress.), other parasites of *Toxoptera aurantiæ* Koch, and many aphis in California and other Western States.

CHALCIDOIDEA (Superfamily)[1]

Chalcid Flies

KEY TO FAMILIES[2]

1. Hind wings not linear, not pedunculate at base; ovipositor issuing far in front of tip of abdomen; antennæ elbowed, and with one, two, or three ring-joints, very rarely without ring-joints 2
   Hind wings linear, pedunculate at base; ovipositor usually issuing just in front of tip of abdomen; antennæ in female most frequently terminating in a distinct fusiform or egg-shaped, solid club, more rarely in a two-jointed club.... **Mymaridæ** p. 817

2. Tarsi 4- or 5-jointed, fore tibiæ armed with a large curved spur; antennæ usually many jointed 3
   Tarsi usually 4-jointed, rarely 3-jointed; very rarely heteromerous; fore tibiæ with a delicate short straight spur; antennæ usually with few joints, at most 9-jointed 16

3. Hind femora much swollen 5
   Hind femora not greatly enlarged 4

4. Males always apterous; abdomen broadly sessile, long and tubular, thickened at base; or broadened apically with a tubercle or filament at each apical angle. (Fig Wasps.) .... **Agaonidæ** p. 815
   Males most often winged, rarely apterous; if apterous the abdomen is normal and not long and tubular 6

[1] L. O. Howard, Biology of *Chalcididæ*. *Proc. U. S. Nat. Mus.*, 14, pp. 567–588, 1892.
W. H. Ashmead, Classification, *Proc. Ent. Soc. Wash.*, 4, pp. 235–236, 242–249, 1897, "Classification of *Chalcidoidea*. *Mem. Carnegie Mus.*, 1, No. 4, ser. No. 21, pp. 225–393, 1904.
J. C. Crawford, "N. A. *Chalcidoidea*." *Jour. N. Y. Ent. Soc.*, 15, pp. 177–183, 1907. "Descriptions of Certain Chalcidoid Parasites." *Tech. Ser.* 19 pt. 2, Bur. Ent., U. S. Dept. Agr. 1910. "New *Hymenoptera*." *Proc. U. S. Nat. Mus.*, 38, pp. 87–90, 1910; 39, pp. 617–623, 1911; 43, pp. 163–188, 1912; 45, pp. 241–260, 309–317, 1913.
A. B. Gahan, "New *Hymenoptera*." *Proc. U. S. Nat. Mus.*, 46, pp. 435–440, 1913; 48, pp. 159–168, 1915; 65, art. 4, pp. 1–23, 1924. "Phytophagous *Chalcidoidea*." *Proc. Ent. Soc. Wash.*, 24, pp. 35–58, 1922.
A. B. Gahan and Margaret M. Fagan, *Type Species of the Genera of Chalcidoidea.* Bul. 124, U. S. Nat. Mus. 1923.
L. Masi, "*Chalcididæ* of the Seychelles Islands." *Novitates Zoöl.*, 24, pp. 121–230, 1917 (*Chalcidoidea*).
A. A. Girault, New Species. *Proc. U. S. Nat. Mus.*, 53, pp. 445–450, 1917; 58, pp. 183–216, 1920. "Chalcid Flies Chiefly from California." *P. C. Jour. Ent. and Zoöl.*, 9, pp. 8–12, 1920.
C. J. Weld, "Studies on Subfamily *Leucospidinæ*. *Proc. U. S. Nat. Mus.*, 61, No. 2427, art. 6. pp. 1–14, 1922.
H. Compere, "New Chalcidoid Parasites and Hyperparasites of the Black Scale." *U. C. Pub. Tech. Bul. Ent.*, 3, pp. 295–326, 1925.
References to Revisions of Special Groups are listed under same.
The manuscript of this superfamily was read and revised by P. H. Timberlake, A. B. Gahan, and H. S. Smith, all of whom made many valuable corrections and additions.

[2] After H. L. Viereck, *Hym. Conn.*, pp. 444–446, 1916.
P. H. Timberlake also erects the family *Tanaostigmatidæ*, but includes the *Eulophidæ*, *Elachertidæ*, and *Entedontidæ* in the family *Tetrastichidæ*.

5. Fore wings, when at rest, folded longitudinally; ovipositor curved over dorsum of abdomen........ **Leucospidæ**
Fore wings not folded; ovipositor not curved over dorsum of abdomen........ **Chalcididæ** p. 849

6. Thorax strongly developed, much arched and deeply punctate........ 7
Thorax not strongly developed........ 8

7. Stigmal vein not well developed, always short and subsessile; second abdominal segment very large and usually enclosing other segments...... **Eucharidæ**
Stigmal vein developed; all abdominal segments visible...... **Perilampidæ** p. 849

8. Pronotum large; antennæ many jointed; notauli complete........ 9
Pronotum small, frequently not visible in the middle; antennæ usually with few joints........ 10

9. Hind coxæ greatly enlarged; ovipositor not prominent; body not metallic; sides of scutel almost straight........ **Eurytomidæ** p. 844
Hind coxæ normal; ovipositor often exserted; body usually metallic; sides of scutel curved........ (Torymidæ) **Callimomidæ** p. 843

10. Mesosternal pleuræ not visible; mid legs long, saltatorial, with a very long tibial spur........ 11
Mesosternal pleuræ distinct; mid legs not saltatorial, first tarsal joint not swollen........ 13

11. Antennæ more than 6-jointed........ 12
Antennæ 6-jointed; marginal vein about as long as subcostal vein **Signiphoridæ** p. 842

12. Antennæ usually 13-jointed; occipital margin of vertex rounded. **Eupelmidæ** p. 843
Antennæ usually 11-jointed; occipital margin of vertex usually acute; notauli obliterated........ **Encyrtidæ** p. 832

13. Antennæ 12- or 13-jointed........ 14
Antennæ 4- to 9-jointed; notauli distinct; middle tibial spur moderately long; stigmal vein very short, nearly obsolete, the knob sessile or subsessile; mesopleura without a femoral furrow........ **Aphelinidæ** p. 827

14. Antennæ usually 12-jointed........ 15
Antennæ 13-jointed, with two ring-joints and three joints to the club; occipital line incomplete........ **Pteromalidæ** p. 822

15. *Abdomen distinctly petiolate; occipital line complete*........ **Spalangiidæ**
Abdomen almost sessile; pronotum scarcely visible in the middle, submarginal vein subangulate, stigmal club often large, notauli distinct; funicle of antennæ 5-jointed........ **Tridymidæ**

16. Tarsi 4- or 5-jointed........ 17
Tarsi 3-jointed; pubescence of wings arranged linearly.... **Trichogrammatidæ** p. 819

17. Submarginal vein entire, furnished with many bristles, postmarginal distinct; hind tibiæ sometimes with two spurs........ 18
Submarginal vein broken, postmarginal sometimes wanting; hind tibiæ with one spur; male antennæ simple........ 20

18. Abdomen sessile or with a distinct petiole that is transverse and smooth; notauli either absent or else represented only by very slight impressions........ 19
Abdomen usually with a distinct petiole; notauli very distinct; antennæ inserted below *middle of face, simple in male; mesonotum with the parapsidal* furrows complete, distinct, entire........ **Elachertidæ** p. 822

19. Hind coxæ very large and strongly compressed; head semiglobose, front deeply, sparsely punctate; antennæ flabellate in male; marginal vein in fore wings usually extraordinarily lengthened, the radius very short, scarcely dilated; mesonotum without furrows........ **Elasmidæ**
Hind coxæ normal; tarsi 4- to 5-jointed, rarely heteromerous; marginal and radial veins normal; postmarginal vein often wanting; mesonotum with com-

plete or incomplete furrows; antennæ often flabellate in male; mesonotum with the parapsidal furrows incomplete or absent, at most only slightly indicated anteriorly . . . . **Eulophidæ** p. 821

20. Submarginal vein very short, either ornate or provided with two bristles; marginal vein very long; postmarginal vein variable, often very short or indistinctly developed; metapleuræ very small; scutel with two bristles near the middle . . . . **Entedontidæ** p. 820

Submarginal usually longer than the marginal vein with from one to five bristles; stigmal vein distinct, never subsessile, usually long; metapleuræ triangular not small; mesopleura with a distinct femoral furrow; postmarginal vein usually absent; scutel with four bristles, all behind the middle, often with two longitudinally impressed lines; abdomen sessile . . . . **Tetrastichidæ** p. 819

AGAONIDÆ. Fig Wasps.

The blastophaga, *Blastophaga psenes* (Linn.) (*Cynips, B. grossorum* Grav.) (Figs. 685, 686), has two adult forms, the winged female which is 2.5 mm. long and shining black, and the apterous male which is 2–2.5 mm., and

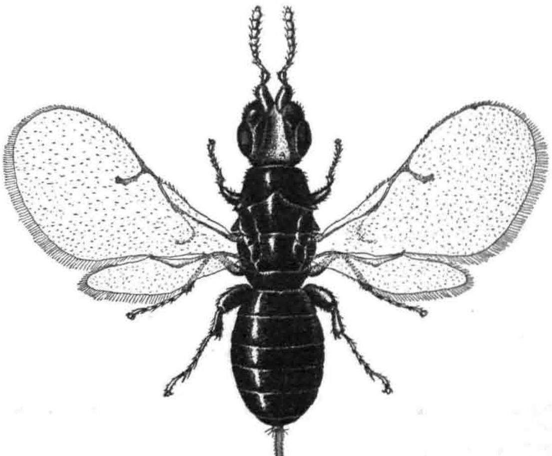

FIG. 685.—The adult female blastophaga, *Blastophaga psenes* (Linn.). (After Condit.)

shining amber brown in color. The female has large compound eyes, three ocelli, ten jointed antennæ, well developed mouth parts and sharp ovipositor; while the male has small compound eyes, well developed mouth parts, no ocelli, and the abdomen drawn out into a long tube which is normally curled

beneath the body. The eggs are very minute, white, elliptical, with a short petiole at one end. The larvæ are very small, legless, and white with brown mandibles. The blastophaga breeds only in certain non-edible figs called caprifigs which are known as the native or wild figs of the Mediterranean region of southwestern Asia and southeastern Europe. Within these figs the females insert their eggs down through the hollow style into the ovaries of the flowers. The ovaries or seeds thus inhabited by the larvæ are frequently referred to as galls. The males issue first and gnaw holes in the galls containing the females, through which openings mating is accomplished. The following day the fully developed and fertilized females enlarge the openings, emerge, and immediately seek other figs in which to lay their eggs. In crawling about over the flowers they carry the pollen to the ovaries, causing cross pollination. In this manner pollen may be carried from a caprifig to a Smyrna fig. The capri tree, the crop of which is the only one in which the insect can lay its eggs on account of the shape of the flowers, produces three distinct crops of caprifigs called respectively, mammæ, profici, and mammoni. The mammæ is the overwintering crop, contains no pollen and cannot, therefore, be used to fertilize the Smyrna figs. The profici figs contain an abundance of gall flowers and pollen and the latter is available at the time the second brood of the insect reaches maturity and also when the flowers of the Smyrna figs are receptive or about one-half to five-eighths inch in diameter, from May to August. This crop is the one used to pollinate the Smyrna crop. The mammoni crop carries the blastophaga through the late summer, fall, and in some cases even through the winter, but in most cases the winter is passed in the mammæ figs which remain on the trees unless destroyed by frost. Only the figs inhabited by the blastophaga remain on the trees. Inasmuch as the Smyrna fig does not develop to maturity without cross pollination, the blastophaga furnishes the only means of transferring pollen from the profici caprifigs to the Smyrna figs, this transfer or process being known as caprification.[1] Several methods are employed to bring about caprification in the orchards. Chief of these is the supplying of profici caprifigs to the orchards when the Smyrna figs are receptive. This is accomplished by hanging wire or other open baskets or boxes containing caprifigs in the trees, the number of caprifigs varying with the size of the tree, from 36 for a tree 6 feet in diameter, to 80 for one of 16 feet in diameter. This number is not supplied all at one time but in equal lots every 3 or 4 days. For every 100 Smyrna fig trees, there are required from 3 to 5 caprifig trees in order to supply a sufficient number of blastophaga to accomplish complete caprification.

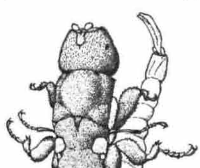

FIG. 686.—The adult male blastophaga, *Blastophaga psenes* (Linn.). (After Condit.)

This important economic insect is native to the Mediterranean region of southern Europe, northern Africa, and Asia Minor, and was first introduced into California by James Shinn, orchardist and nurseryman, at

[1] For a complete discussion of caprification, see *Caprifigs and Caprification* by I. J. Condit, Bul. 319, Cal. Agr. Exp. Sta. 1920.

Niles, California, in 1890 through the advice and help of Gustav Eisen of San Francisco and J. Bliss, a missionary in Smyrna.[1] It is now used throughout the Smyrna fig-growing sections of California and is occasionally also used to pollinate other varieties of figs as well.

MYMARIDÆ.[2] Mymarid Parasites.

Polynema howardi (Ashmead) (*Cosmocoma, C. elegans* How.). Length 0.9 mm., shining black, antennal scape and pedicel brown, tarsi yellow with last joint dark. It

FIG. 687.—*Polynema eutettixi* Girault. Adult female. (After Severin.)

is wrongly recorded from *Kermes cockerelli* Ehrh. at Santa Rosa, California, and rightly recorded from eggs of *Ceresa bubalus* Fabr. in Colorado by C. P. Gillette and C. F. Baker.[3]

Polynema eutettixi Girault (Fig. 687). Length 0.6–0.9 mm., black with brown legs and antennæ, and the petiole yellow. Reared from eggs of *Eutettix tenellus* (Baker) in saltbushes in the San Joaquin Valley, California, by H. H. P. Severin.

Polynema imitatrix Gahan.[4] Length 0.88–0.95 mm., polished black, basal joints

[1] *Insect Life*, 4, pp. 128–129, 1891.

[2] A. A. Girault, "N. A. *Mymaridæ.*" *Ann. Ent. Soc. Am.*, 1, pp. 179–195, 1908; 2, pp. 22–29, 1909. *Jour. N. Y. Ent. Soc.*, 18, pp. 236–258, 1910. *Trans. Am. Ent. Soc.*, 37, pp. 253–324, 1911. *Ent. News*, 27, pp. 4–8, 1916.

This family is placed in the *Proctotrypoidea* by some writers.

[3] *Cat. Hemiptera of Colorado.* Colo. Agr. Exp. Sta. Bul. 31, Tech. Ser. 1, p. 66, 1895.

[4] *Proc. Ent. Soc. Wash.*, 20, pp. 24–25, 1918. Orig. desc.

of antennæ and petiole of abdomen reddish. Parasitic on eggs of *Stictocephala festina* (Say) in Arizona.

Polynema striaticorne Girault. Length 1.64 mm., robust, reddish brown to blackish, portions of antennæ and legs yellow. Reared by R. H. Smith from *Anuraphis bakeri* (Cowen) in Idaho. Probably secondary on *Pachyneuron siphonophoræ* (Ashm.) or *Aphelinus lapisligni* How. Also occurs in Colorado and ranges to the Atlantic.

Anagrus armatus (Ashmead) (*Litus*). Length 0.5 mm., reddish amber. The dusky form known as the variety *nigriceps* Girault is an effective egg parasite of *Empoa rosæ* (Linn.) in Oregon, and may kill as high as 33 per cent of the eggs, according to Leroy Childs.[1]

Anagrus giraulti Crawford [2] (Fig. 688). Length 0.5 mm., head and abdomen brown, thorax yellow and brown. Reported as parasitic on *Phthorimæa operculella* (Zeller) in

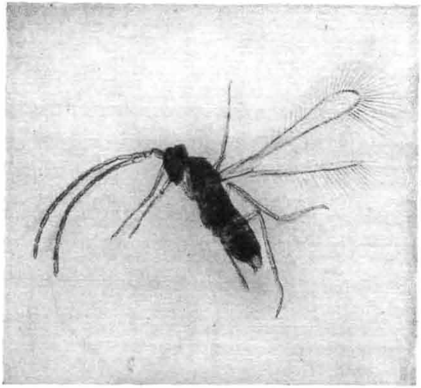

FIG. 688.—*Anagrus giraulti* Crawford. Adult male. (After Severin.)

Southern California, but this may be an error since C. F. Stahl has reared it from the eggs of *Eutettix tenellus* (Baker), and also from eggs of *Empoasca* sp., in potato plants in California.

Gonatocerus gibsoni Crawford. Length 1 mm., very dark brown, extreme base of abdomen and portions of legs yellow, abdomen strongly compressed. Parasitic on the eggs of *Dræculacephala mollipes* (Say) in Arizona.

Gonatocerus ornatus Gahan. Length 0.9 mm., shining black with whitish spots and lines on the head and thorax, antennæ partly brownish, and the legs partly pale. Parasitic on the eggs of *Stictocephala festina* (Say) in Arizona.

Camptoptera [3] *pulla* Girault. Length 0.75–0.84 mm., uniformly grayish black. Reared from leaves infested with *Aleyrodes* sp. and *Heliothrips fasciatus* Pergande in Southern California and probably parasitic on the former. Also occurs in Illinois.

Alaptus [4] *eriococci* Girault. Length 0.62 mm., wholly dusky brown. Parasitic on *Eriococcus araucariæ* Mask. and *Chrysomphalus aurantii* (Mask.), in Southern California.

[1] Bul. 148, Ore. Agr. Exp. Sta., p. 27, 1918.
[2] *Proc. U. S. Nat. Mus.*, 45, p. 259, 1913. Orig. desc.
[3] A. A. Girault, "Mon. Genus *Camptoptera*." *Ann. Ent. Soc. Am.*, 2, pp. 27–29, 1909.
[4] A. A. Girault, "Mon. Genus *Alaptus*." *Ann. Ent. Soc. Am.*, 1, pp. 179–195, 1908.

Alaptus iceryæ Girault. Length 0.65 mm., pale brown. Reared from male pupa of *Icerya purchasi* Mask. and from *Aspidiotus camelliæ* Sign. in Southern California by D. W. Coquillett.

TRICHOGRAMMATIDÆ.[1] Trichogrammatid Parasites.

Trichogramma minutum Riley (*T. minutissimum* Packard, *T. pretiosum* Riley, *T. odontotæ* Howard). Length 0.3 mm., mostly yellow. A cosmopolitan parasite on the eggs of many insects, including those of *Heliothis obsoleta* (Fabr.), *Ceramica picta* (Harris), *Laphygma frugiperda* (A. & S.), *Alabama argillacea* (Hbn.), *Autographa brassicæ* (Riley), *Protoparce sexta* (Johan.), *Estigmene acræa* (Drury), *Carpocapsa pomonella* (Linn.), *Ianassa lignicolor* Walk., *Vanessa atalanta* (Linn.), *Eurymus eurytheme* (Bdv.), and many other *Lepidoptera*, and also from the eggs of *Eriocampoides limacina* (Retz.), *Ametastegia glabrata* (Fallén), and *Pteronidea ribesi* (Scopoli). It is very common throughout the entire country and abundant in the Western States.

Abbella auriscutellum Girault. Length 0.6 mm., black, the legs black and yellow, the scutellum bright golden yellow, and the abdomen suffused with yellow. Parasitic on the eggs of *Draeculacephala mollipes* (Say) in Arizona.

Abbella perditrix Gahan. Length 0.85 mm., pale lemon yellow, portions of the antennæ and tarsi black. Parasitic on the eggs of *Stictocephala festina* (Say) in Arizona.

Abbella subflava Girault. Length 0.65 mm., pale lemon yellow, marked with fuscous. Parasitic on eggs of a leafhopper in Washington and reared from eggs of *Eutettix tenellus* (Baker) in California by H. H. P. Severin. Also occurs in the Middle and Eastern States.

Oligosita subfasciatipennis (Girault) (*Westwoodella*). Length 0.8 mm., tarsi 3-jointed; lemon yellow or pale green. Parasitic on eggs of leafhopper in wheat, Pullman, Washington.

Oligosita sanguinea Girault *claripes* Girault. Secondary parasite of *Asphondylia websteri* Felt in Arizona. *O. americana* Ashm. has been reared from leafhopper eggs in New Mexico.

TETRASTICHIDÆ. Tetrastichid Parasites.

Tetrastichus blepyri Ashmead. Length 0.8 mm., shining blue-black or black. Parasitic on *Chalcaspis phenacocci* (Ashm.) from *Phenacoccus cevalliæ* Ckll., infesting *Cevallia* in New Mexico; also reared by P. H. Timberlake and C. P. Clausen[2] from *Zarhopalus corvinus* (Gir.), *Anagyrus subalbicornis* (Gir.), *Pseudleptomastix squammulata* Gir., *Chrysoplatycerus splendens* (How.), and *C. ferrisi* Timb. from *Pseudococcus maritimus* (Ehrh.); *Aphycus physokermis* Timb., *Microterys mazzinini* Gir., *Coccophagus albicoxa* How. from *Physokermes insignicola* (Craw); *Anagryus* sp., from *Amonostherium lichtensiodes* (Ckll.); *Coccophagus lecanii* Fitch, from *Lecanium corni* Bouché; *Aphycus lounsburyi* How. from *Saissetia oleæ* (Bern.); probably *Pachyneuron californicum* Gir.; and many other coccid primary parasites in California and neighboring Western States.

Tetrastichus bruchophagi Gahan.[3] Length 1.8 mm., dark blue-green, antennæ dark brown at tips, apices of the femora, tibiæ, and tarsi, except the black apical joint, yellow. Parasitic on *Bruchophagus funebris* Howard, and often destroying as high as 50 per cent of the immature stages of the host in Arizona, California, Oregon, and other States in the west and in the east.

Tetrastichus californicus Ashmead. Length 2 mm., entirely shining black. Reared from galls of *Andricus pomiformis* (Bass.) in company with *Eurytoma californica* Ashm. and is probably parasitic on the latter.

Tetrastichus doteni Crawford. Length 2 mm., shining dark olive green, the antennæ and parts of the legs brown. Parasitic on *Microbracon hebetor* (Say), *Meraporus*, sp., and *Pteromalus* sp. in Nevada. *Tetrastichus rosæ* Ashm. has been reared from galls of *Diplolepis* spp. in Colorado and British Columbia.

Tetrastichus venustus Gahan. Length 1.5 mm., pale orange-yellow with black markings. Reared from *Bruchophagus funebris* How., with its parasites, from alfalfa seed in California.

Hyperteles lividus (Ashmead) (*Oxymorpha livida* Ashm.). Length 2.5 mm., dark bluish black with the three basal tarsal joints yellow. Parasitic on the hibernating larvæ of *Anarsia lineatella* Zeller in California.

[1] A. A. Girault, "*Trichogrammatidæ*." *Trans. Am. Ent. Soc.*, 37, pp. 1–42, 43–83, 1911.
[2] *U. C. Pub. Tech. Bul. Ent.*, 3, p. 251, 1924.
[3] T. D. Urbahns, *Jour. Agr. Research*, 8, pp. 277–282, 1917.

Thripoctenus russelli Crawford.[1] Length 0.6 mm., head and thorax black, abdomen brown with a large flavous basal spot, legs and antennæ reddish. Parasitic on *Heliothrips fasciatus* Perg., *Thrips tabaci* Lind., and *Frankliniella tritici* (Fitch) in California. As high as 70 per cent of the first species may succumb to the attacks of this minute parasite.

ENTEDONTIDÆ. Entedontid Parasites.

Derostenus arizonensis Crawford. Length 0.7–1.12 mm., green with bronze reflections, antennæ brown, apical margins of abdominal segments black, legs black with reddish and white portions. Parasitic on larvæ and puparia of *Agromyza scutellata* Fallén in Utah and California.

Derostenus punctiventris Crawford is similar to the preceding species but wings have a stigmal cloud. Parasitic on *Agromyza scutellata* Fallén and *A. parvicornis* Loew in Wyoming and Utah.

Derostenus pictipes Crawford. Length 1 mm., similar to the two preceding species, but the hind tibiæ lack the pale basal ring. Parasitic on *Agromyza scutellata* Fallén in Utah and on *A. coquilletti* Malloch in Colorado.

Pleurotropis albitarsis Ashmead (*Asecodes*). Length 1.5–2 mm., shining blue-black with brassy reflections. Reared as a tertiary parasite through *Dibrachys boucheanus* (Ratz.) on *Iseropus cœlebs* (Walsh), on various caterpillars in the east and secondary through *Cheiropachys colon* (Linn.) on *Magdalis ænescens* Lec. in Oregon and Washington.

Pleurotropis rugosithorax Crawford. Length 1.5 mm., bluish, the thorax sculptured. Parasitic on *Agromyza scutellata* Fallén on alfalfa in Utah.

Pleurotropis tarsalis (Ashm.) (*Holcapelte*). Length 1–1.5 mm., blue-black, the three basal joints of the tarsi white. Reared from sphinx caterpillar along with *Comedo*

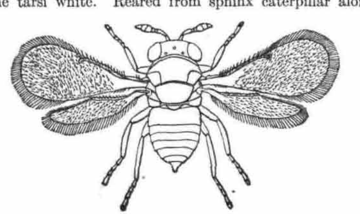

FIG. 689.—The aleyrodid parasite, *Euderomphale flavimedia* (Howard). (After Howard.)

kœbelei Cwfd., *Apanteles smerinthi* Riley, and *Hypopteromalus percursor* Girault in Northern California.

Pleurotropis utahensis Crawford. Length 2–2.5 mm., green with brassy reflections. Parasitic on *Agromyza parvicornis* Loew and on *Cephus cinctus* Norton in Utah, and on the latter in Montana.

Closterocerus utahensis Crawford (*C. californicus* Girault). Length 0.75 mm. iridescent purple or bluish with green reflections, legs partially light. Reared from *Agromyza parvicornis* Loew and *A. scutellata* Fallén in Utah, and from the oak aphis, *Symydobius chrysolepidis* Swain in Southern California.

Entedon bigeloviæ Ashmead. Length 2.5–3 mm., bronze green to bluish green, the abdomen brassy black. Reared from *Eurosta bigeloviæ* Ckll. in New Mexico, Utah, and Oregon. *Entedon occidentalis* Girault is 3.5 mm., robust, and much like the preceding species. It is recorded from Oregon, California, and Utah.

Chrysocharis ainsliei Crawford. Length 1.25 mm., blue-green and bronzy, legs partly whitish. Parasitic on *Agromyza scutellata* Fallén in Utah, Idaho, Arizona, and California. *Chrysocharis parksi* Crawford is a similar species reared from *Agromyza* sp. in Utah.

Mestocharis wilderi Howard. Length 1.5 mm., shining black with greenish blue re-

[1] H. M. Russell, *Tech. Ser.* 23, pt. 2, Bur. Ent. U. S. Dept. Agr. 1912.

flections. Parasitic on *Tromatobia rufopectus* (Cresson) in the egg masses of the spider, *Epeira angulata* Clerck, in Southern California. It is also recorded in New York.

The aleyrodid parasite, *Euderomphale flavimedia* (Howard) (*Gyrolasia, Pteropterix*) (Fig. 689). Length 0.7 mm., expanse 1.9 mm., antennæ 8-jointed, tarsi 4-jointed, wings with long cilia and a dusky patch in the fore pair, color metallic black, the ventral surface of the abdomen yellowish. This is a very common and abundant parasite on the immature stages of *Aleyrodes pruinosa* Bemis and *A. spiræoides* Quaint. at Berkeley, California, and also attacks *A. aureocincta* Ckll., in New Mexico. (*Can. Ent.*, 48, p. 410, 1916. Syn. by P. H. Timberlake.)

EULOPHIDÆ.[1] Eulophid Parasites.

Comedo kœbelei Crawford (Fig. 690). Length 2.25 mm., head and thorax blue-green, abdomen brown with large white basal spot, legs brown and whitish. Reared from the

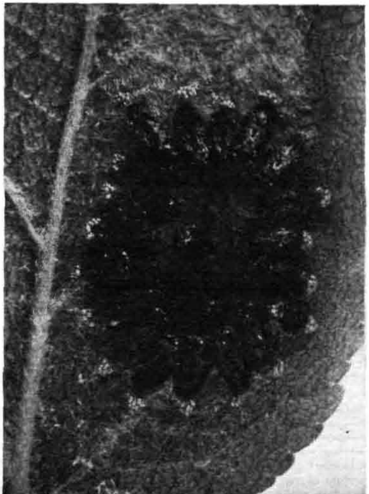

FIG. 690.—Pupa cases of *Comedo kœbelei* Crawford, the larvæ of which emerged from a caterpillar of the California tussock moth, *Hemerocampa vetusta* (Bdv.).

larvæ of *Hemerocampa vetusta* (Bdv.), along with the hyperparasite, *Pleurotropis tarsalis* (Ashm.) in the San Francisco Bay region, California. The very interesting small black pupæ have one end bright yellow and are arranged in a circle about the dead body of the host.

Diaulinus begini (Ashmead) (*Diaulus*).[2] Length 1.5 mm., blue-green, apical portions of the legs yellow; eggs smooth, oblong 0.5 mm. long. Females oviposit on host

[1] A. A. Girault, "Miscl. N. A. *Eulophidæ*." *Proc. U. S. Nat. Mus.*, 51, pp. 39–52, 125–133, 1916.

[2] F. M. Webster and T. H. Parks, *Jour. Agr. Research*, 1, p. 79, 1913.

through tissues above the mines; larvæ feed externally on larvæ of host and pupate in the mines. Abundant in California and reared by the writer from puparia of *Phytomyza albiceps* Meigen and *P. chrysanthemi* Kow. at Berkeley, California; and by Webster and Parks from *Agromyza parvicornis* Loew and *A. scutellata* Fallén in New Mexico, Arizona, Utah, Wyoming, Idaho, and California. It also occurs in the Middle West.

Diaulinus websteri Crawford.[1] Length 1.25 mm., dark green, tips of femora, bases of tibiæ, and tarsi, except apical joint, whitish. Parasitic on *Agromyza jucunda* v. d. W., *A. parvicornis* Loew, *A. scutellata* Fallén, and on *Cerodonta femoralis* Meig. form *dorsalis* Loew. Reported from Arizona, Utah, Nevada, and California.

ELACHERTIDÆ.

Cirrospilus flavoviridis Crawford. Length 0.8–1 mm., brilliant green, legs largely or entirely yellow, body marked with yellow. Reared from *Agromyza parvicornis* Loew and *A. scutellata* Fallén in Utah and from *Cerodonta femoralis* Meig. form *dorsalis* Loew in Nevada. May be a secondary parasite.

Zagrammosoma centrolineata Crawford. Length 2 mm., pale yellow. Reared from *Gracilaria elongella* (Linn.) in Central California and from *Cameraria mediodorsella* (Braun) in Southern California.

Diaulinopsis callichroma Crawford. Length 1 mm., bronzy green, the legs coppery and pale yellow. Reared from *Agromyza scutellata* Fallén and *A. jucunda* v. d. W. in Arizona.

PTEROMALIDÆ. Pteromalid Parasites.

Dibrachys boucheanus (Ratzeburg) (*Pteromalus*). Length 1.20–1.25 mm., head and thorax greenish, abdomen dark brown; the whole body often appears shining black. A very common parasite throughout the country and often abundant in the west. It is normally parasitic on *Iseropus cœlebs* (Walsh), *Ephialtes sanguinipes* (Cresson), *Hyposoter fugitivus* (Say), and many other primary parasites on *Malacosoma americana* (Fabr.), *M. californica* (Pack.), *M. constricta* (Stretch), *Hemerocampa vetusta* (Bdv.), *Notolophus antiqua* (Linn.), *Galleria mellonella* (Linn.), *Lycophotia margaritosa* (Haw.), *Carpocapsa pomonella* (Linn.), and other *Lepidoptera*. It has been reared in great numbers from pupæ of *Carpocapsa pomonella* (Linn.), which showed little or no work of other parasites, and appears to be capable of living also as a primary parasite. The tertiary parasite, *Pleurotropis albitarsis* Ashm., is often reared from it.

Dibrachys clisiocampæ (Fitch) (*Cleonymus, Semiotellus, Pteromalus*) has been reared from the larvæ of *Galleria mellonella* (Linn.) in the east and from *Phthorimæa operculella* (Zeller) in Southern California. It is probably also secondary.

Dibrachys diacrisiæ (Crawford) (*Cœlopisthia*). Length 2.5 mm., brown, the base of the abdomen metallic green. Reared from *Diacrisia virginica* (Fabr.) in Colorado.

Pteromalus eurymi Gahan. Length 2–4.5 mm., robust, shining bronze or brassy, portions of the legs reddish and brown, portions of the abdomen appearing blackish. An important natural enemy of *Eurymus eurytheme* (Bdv.), in Arizona, Utah, and California.[2]

Pteromalus hemileucæ Gahan. Length 3.8 mm., head and thorax dark green, thorax bronzy or black with green iridescence, antennæ reddish and black, legs green, brown, and pale yellow. Reared from *Hemileuca oliviæ* Ckll. in New Mexico.

Pteromalus puparum (Linn.) (Fig. 691). Length 1.3–4 mm., green, antennæ brown, fuscous and yellow, legs green and bronze; abdomen of the male golden above and the femora and tibiæ yellow. This is the most important parasite of the cabbage butterfly, *Pieris rapæ* (Linn.), having been introduced into North America from Europe. The adults lay from 20–40 eggs in each chrysalid and the winter is normally passed as larvæ within the host. Maturity is reached in the spring. There are several generations during the summer. Other hosts are *Vanessa cardui* (Linn.), *V. atalanta* (Linn.), *Aglais antiopa* (Linn.), and other *Lepidoptera*. It is also a hyperparasite on *Hyposoter fugitivus* (Say), *Rogas* spp., *Microbracon* spp., and other *Hymenoptera*. In the west it is recorded in Colorado, Nevada, and California. The variety *vanessæ* Harris is larger and darker in color. It is parasitic on *Aglais antiopa* (Linn.) and other butterflies, and ranges west into Colorado.

[1] J. C. Crawford, "*Diaulinus* spp." *Proc. U. S. Nat. Mus.*, 43, pp. 183–185, 1913.
[2] V. L. Wildermuth, Bul. 124, Bur. Ent. U. S. Dept. Agr., p. 21, 1914.

Eupteromalus[1] *viridescens* (Walsh) (*Glyphe, Gastrancistrus*). Length 1.8 mm., iridescent green, legs amber. Parasitic on *Ochlodes sylvanoides* (Bdv.) through *Apanteles* sp. and *Amblyteles astutus* (Holm.) in Southern California.

Hypopteromalus percursor Girault (*H. percussor* Gir.). Length 2.5 mm., dark green with brassy reflections, antennæ brown, legs black and white. Reared from larvæ of the noctuid moth, *Luceria tranquilla* (Grote) (*Zotheca*), in Washington, upon which it is probably secondary. Reared by writer from *Apanteles smerinthi* Riley in northern California.

Aplastomorpha calandræ (Howard) (*Pteromalus, Meraporus vandinei* Tucker, *Neocatolaccus australiensis* Gir., *Aplastomorpha pratti* Ashm.). Length 1.15 mm., head

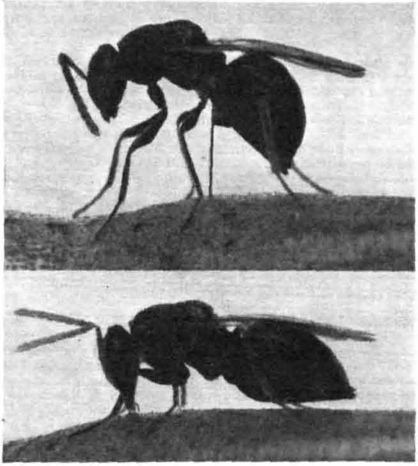

FIG. 691.—The cabbage butterfly parasite, *Pteromalus puparum* (Linn.). Adult female ovipositing in chrysalis of the cabbage butterfly, *Pieris rapæ* (Linn.), and feeding from the puncture made by the ovipositor. (Photos by S. B. Doten.)

and thorax steel blue, abdomen yellowish brown at base and remainder shining black, antennæ and portions of legs brownish, some specimens coppery green. A cosmopolitan species occurring in various parts of the country and in the Southwest. Parasitic on *Sitodrepa panicea* (Linn.), *Mylabris quadrimaculatus* (Fabr.), and *Sitophilus oryza* (Linn.).

Habrocytus languriæ Ashmead. Length 2.5–3 mm., black with metallic brassy blue or green reflections, legs partly yellow. Parasitic on the eroytlid beetle, *Languria mozardi* Latr., in Arizona. It ranges into Virginia where it attacks the above host and *L. angustata* (Beauv.). *Habrocytus simillimus* Gahan, reared from *Agromyza gibsoni* Malloch from Arizona, may prove to be the same species, according to A. B. Gahan.

Habrocytus medicaginis Gahan.[2] Length 1.7 mm., reddish and black, the legs yellow and black. The adults begin to appear in March and are most abundant in July and

[1] A. B. Gahan, *Proc. Ent. Soc. Wash.*, 22, p. 240, 1920.
[2] T. D. Urbahns, *Jour. Agr. Research*, 7, p. 147, 1916.

August. Hibernation is in the larval or, rarely, in the pupal stage. Parasitic on *Bruchophagus funebris* How. in the seeds of alfalfa and clovers in New Mexico, Arizona, Utah, Idaho, Oregon, California, and undoubtedly other Western States, as well as along the eastern slopes of the Rocky Mountains. *Habrocytus obscuripes* Ashm. and *H. rosæ* Ashm. are parasitic on *Diplolepis* spp. (*Rhodites* spp.) in Colorado.

Eutelus bruchophagi Gahan. Length 1.75 mm., iridescent green and black, legs partly reddish brown. Parasitic on *Bruchophagus funebris* How. in Utah. *Eutelus flavipes* Walker is a European and North American species reared from the syrphid fly, *Chilosia alaskensis* Hunter, in Washington by H. E. Burke.[1] *Eutelus mayetiolæ* Gahan has been reared from *Phytophaga destructor* (Say) in California by C. M. Packard.[2]

Merisus destructor (Say) (*Ceraphron, Bætomus*).[3] Length 1.9–2 mm., black with blue and green iridescence, legs banded with yellow. A common parasite of *Phytophaga destructor* (Say) in many parts of North America and recorded in California, by A. Koebele.

Pachyneuron altiscuta Howard. Length 2 mm., black with blue reflections, antennæ pale, legs pale with dark femora. Reared with *Aphycus lounsburyi* How., *Scutellista cyanea* Mots., and *Quaylea whittieri* (Girault) from black scale, *Saissetia oleæ* (Bern.), in Southern California by the writer. It is a secondary parasite.

Pachyneuron californicum Girault. Length 1.5–2 mm., bright metallic green, portions of antennæ and legs pale. Reared as a secondary parasite from *Coccus hesperidum* Linn., *Lecanium corni* Bouché, and *Saissetia oleæ* (Bern.) in various parts of California. It may in turn be parasitized by the tertiary, *Tetrastichus blepyri* Ashm.

Pachyneuron siphonophoræ (Ashmead) (*Encyrtus, Pachyneuron micans* How., *Aphidencyrtus, Propachyneuronia*). Length 1 mm., black, abdomen brown on sides, and venter, coxæ, tibiæ, and tarsi yellow. A secondary parasite on *Brevicoryne brassicæ* (Linn.), *Toxoptera graminum* Rond., *Aphis nerii* Fonsc., *A. gossypii* Glover, and other *Aphididæ* through *Lysiphlebus testaceipes* (Cress.). It occurs throughout the United States and the writer has frequently reared it in California.

Rhaphitelus maculatus Walker (*Raphitelus*). Length 0.5–1 mm., green with bronze and brassy reflections, legs partly yellow. A European parasite reared from the burrows of *Scolytus rugulosus* Ratz. at Venutra, California, by the writer and determined by A. B. Gahan.

Cheiropachys colon (Linn.) (*Sphex, Chiropachys*). Length 1 mm., metallic coppery and green, first and second joints of the antennæ and the portions of the legs yellowish. Commonly parasitic on *Scolytus rugulosus* Ratz. in Southern California and in the east and on *Magdalis ænescens* Lec. in Oregon, Washington, and British Columbia. It is in turn parasitized by *Pleurotropis albitarsis* Ashm.

Amblymerus justicia Girault. Length 1 mm., metallic blue-black, the antennæ and legs partly brownish. It has been reared by the writer from the galls of *Diarthronomyia hypogœa* (F. Löw) at Berkeley, California.

Arthrolytus æneoviridis Girault. Reared from *Bucculatrix thurberiella* Busck on cotton in Arizona.

Dinotus agrili Rohwer. Length 2.5 mm., bronzy green, with bronze more noticeable on the scutellum and middle of abdomen; scape of antennæ, tibiæ, and tarsi reddish; the apices of the hind tibiæ whitish. Reared from *Agrilus angelicus* Horn in Southern California.

Dibrachoides dynastes (Förster) (*Pteromalus*). A European parasite of *Phytonomus posticus* (Gyll.) introduced into Utah to prey on this insect. It has been taken from pupæ of *P. nigrirostris* (Fabr.) in Washington by L. P. Rockwood.[4]

Eurydinota lividicorpus Girault. Length 1.65 mm., robust, dark metallic blue, base and apex of the tibiæ and the tarsi white. Reared from the pupæ of *Coleophora sacramenta* Heinrich, in the San Francisco Bay region by W. M. Davidson and by the writer, and in Southern California by the former. *Eurydinota flavicorpus* Girault was also reared from the same host in the San Francisco Bay region, California, by W. M. Davidson.

[1] *Circ.* 61, Bur. Ent. U. S. Dept. Agr., p. 7, 1905.

[2] *Proc. U. S. Nat. Mus.*, 55, p. 128, 1920.

[3] A. Koebele, Bul. 22, Bur. Ent. U. S. Dept. Agr., p. 93, 1890.
C. M. Packard, "Life Histories and Methods of Rearing Hessian Fly Parasites." *Jour. Agr. Research*, 6, pp. 367–381, 1916.

[4] *Can. Ent.*, 52, p. 39, 1920.

Heteroschema prima Gahan. Length 1.9 mm., head and thorax black, abdomen metallic blue, portions of antennæ and legs reddish. Parasitic on *Agromyza gibsoni* Malloch in Arizona.

Urolepis rufipes Ashmead. Length 3 mm., bronzy black, legs and antennæ partly yellow. Parasitic on the pupæ of *Ephydra hians* Say thrown upon the beach around Mono Lake, California.

The California tomocera, *Tomocera californica* Howard (*Diplogaster*) (Fig. 692). Length 2.1 mm., head, face, scape of the antennæ, and portions of legs pale reddish brown; thorax metallic black; abdomen blue-black with brown area at base of venter. A common parasite on black scale, *Saissetia oleæ* (Bern.), *Coccus hesperidum* Linn., and other *Coccidæ*. It occurs in California and Hawaii.

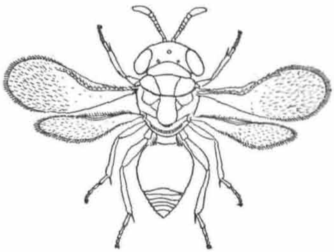

FIG. 692.—The California tomocera, *Tomocera californica* Howard. (After Howard.)

Ophelosia crawfordi Riley. Length 2 mm., pale yellow throughout, the apical joint of the antennæ of the female dark and the fore wings with a conspicuous cloud near the middle. It was introduced into California from Australia in 1890 to prey upon *Icerya purchasi* Mask., but apparently never became established in California.

The scutellista, *Scutellista cyanea* Motschulsky [1] (Fig. 693). Length 2–3 mm., short, robust, scutellum very large; metallic blue-black throughout; wings hyaline and short; eggs white, oblong, usually with long stalk; larvæ 4–5 mm. long, white, pointed at both ends. The larvæ live under the mature scales and feed on the eggs. Pupation occurs under the scales and the adults emerge through a large circular hole in the dorsum of the host. There are several broods a year. The black scale, *Saissetia oleæ* (Bern.), is the preferred host, but it has also been reared from *Phenacoccus artemisiæ* Ehrh., in Southern California by the writer, from *Ceroplastes floridensis* Comst. in Florida, from *C. cirripediformis* Comst., in Southern Europe, and from *C. geleatus* Newst., in Southern Africa. It is an oriental species occurring in Southern Asia in addition to the above localities and was introduced into California from South Africa in 1902 through the efforts of L. O. Howard and C. P. Lounsbury. This well known parasite has become generally distributed throughout Southern California and has at times proven quite effective in certain localities. Its efficiency has been greatly reduced by the effective work of the secondary parasite, *Quaylea whittieri* (Gir.).

[1] H. J. Quayle, Bul. 223, Cal. Agr. Exp. Sta., pp. 179–188, 1911.

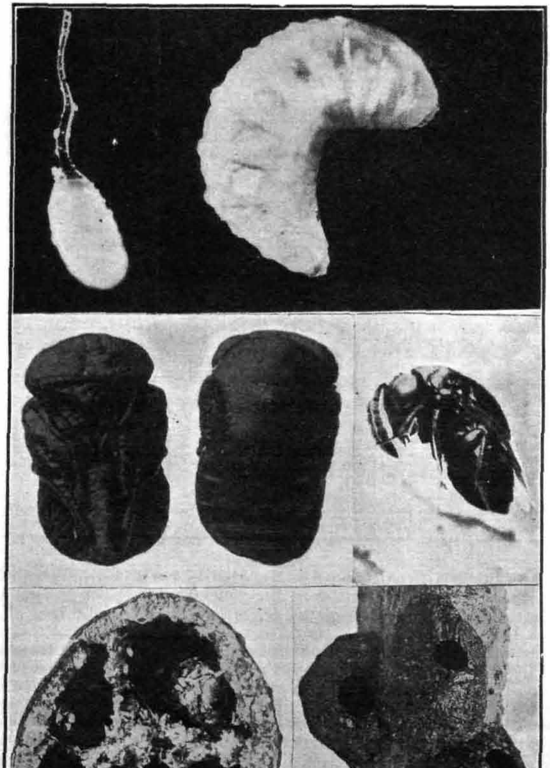

FIG. 693.—The scutellista, *Scutellista cyanea* Mots. Egg with pedicel; larva; pupæ; adult; inverted black scale showing pupæ within; black scales showing exit holes of the adults. (After Quayle.)

APHELINIDÆ.[1] Aphelinid Parasites.

Mesidia gillettei Howard. Length 1.02 mm., dull honey yellow, antennæ and legs paler, abdomen ovate, ovipositor not exserted. Reared from *Brachycolus tritici* Gill. by C. P. Gillette in Colorado.

The common chalcid, *Aphelinus diaspidis* Howard,[2] (Fig. 694). Length 0.78 mm., wing expanse 1.89 mm., dull yellow throughout, the antennæ darker at apices; the first five abdominal segments each with interrupted dusky band near middle; eggs pale yellowish white, 0.16 x 0.96 mm., with short stalk at one end; larvæ pyriform, 0.75 mm. long, tapering more towards posterior end, white, with 14 segments; pupæ dark yellow. The eggs are deposited on the bodies of the scale insects beneath the shells and hatch in from four to five days. The larvæ live under the shells feeding externally on the host. The species is sexual and parthenogenetic.

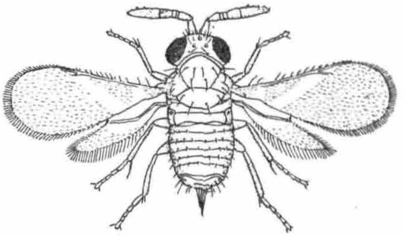

FIG. 694.—The common chalcid, *Aphelinus diaspidis* Howard. (After Howard.)

Common throughout the United States, Hawaii, and Japan, and abundant in California. Parasitic on *Aulacaspis rosæ* (Bouché), *Aspidiotus camelliæ* Sign., *A. juglans-regiæ* Comst., *A. perniciosus* Comst., *Chrysomphalus aurantii* (Mask.), *Lepidosaphes ulmi* (Linn.), and other *Coccidæ*.

Aphelinus fuscipennis Howard. Length 0.6 mm., yellow throughout, scutellum dark at tip, abdomen with five dusky transverse lateral bands. Occurs in Southern Europe and throughout North America and is the most important parasite of the San José scale, *Aspidiotus perniciosus* Comst., on the latter continent. It is common in California. Also parasitic on *Aspidiotus camelliæ* Sign., *A. hederæ* (Vall.), *A. uvæ* Comst., *Chionaspis euonymi* Comst., *Diaspis echinocacti* (Bouché), *Lepidosaphes gloveri* (Pack.), *L. ulmi* (Linn.), and other *Coccidæ*. This species is believed by E. W. Rust, P. H. Timberlake, and A. B. Gahan, to be identical with the preceding one.

[1] L. O. Howard, "Rev. of *Aphelininæ* N. A. *Tech. Ser.* 1, Bur. Ent. U. S. Dept. Agr., 1895. New Genera and Species of *Aphelininæ*, with Revised Table of Genera." *Tech. Ser.* 12, pt. 4, Bur. Ent. U. S. Dept. Agr., pp. 69–88, 1907. "Aphis Feeding Species of *Aphelinus*." *Ent. News*, 19, pp. 365–367, 1908.
Ricardo G. Mercet, *Los Afelininos. Inst. Nac. de Ciencias Fisico-Naturales, Trabajos Del Museo de Ciencias Nat., Madrid*, No. 10, pp. 1–306, 1912.
A. B. Gahan, "Notes on *Aphelininæ* with Descriptions of New Species." *Proc. U. S. Nat. Mus.*, 55, pp. 403–407, 1919.

[2] L. O. Howard, *Ann. Rept. U. S. Dept. Agr.*, p. 355, 1880. Orig. desc. *Insect Life*, 6, p. 233, 1893.
H. J. Quayle, *Jour. Econ. Ent.*, 398, 3, p. 1910.

Aphelinus lapisligni Howard.[1] Length 1.05 mm., expanse 2.19 mm., body shining black, antennæ largely whitish, legs partly whitish, wings infuscated below marginal vein. Reared by L. P. Rockwood from *Anuraphis bakeri* (Cowen) in Oregon and by R. H. Smith from the same host, and also from *Anuraphis helichrysi* (Kalt.) in Idaho. Smith reports as high as 97 per cent of the first host parasitized by this insect in Idaho. From the same aphis he also reared the secondaries, *Polynema striaticorne* Gir., *Pachyneuron siphonophoræ* (Ashm.) and *Xystus leguminosa* (Weld).

Aphelinus longiclavæ Mercet (*A. capitis* Rust).[2] Length 0.65–0.75 mm., various shades of yellow, orange and brown, the fore wings often with a distinct fuscous patch covering the basal half. This is a very common species in California where it has been reared from *Diaspis zamiæ* Morgan, *Chionaspis pinifoliæ* (Fitch), *Aspidiotus camelliæ* Sign., and *Aspidiotus hederæ* (Vall.). It also occurs in Spain.

Aphelinus mali (Haldeman) (*Eriophilus*, *Blastothrix rosæ* Ashm.). Length 1.2 mm., dark brown to nearly black, base of abdomen yellow, legs and antennæ partly yellow. Occurs throughout the United States and ranges into the Southwestern States. Parasitic on *Brevicoryne brassicæ* (Linn.), *Toxoptera graminum* Rond., *Macrosiphum rosæ* (Linn.), *Eriosoma lanigera* (Hausm.), *Prociphilus fraxinifolii* (Riley), and other *Aphididæ*.

Aphelinus mytilaspidis Le Baron. Length 0.64 mm., expanse 1.28 mm., bright lemon yellow. Occurs throughout Southern Europe, the United States, and is common in California. Parasitic on *Diaspis carueli* Targ., *Aulacaspis rosæ* (Bouché), *Chionaspis pinifoliæ* (Fitch), *Lepidosaphes ulmi* (Linn.), *Aspidiotus hederæ* (Vall.), and *A. perniciosus* Comst.

The golden chalcid, *Aphelinus chrysomphali* Mercet (*A. quaylei* Rust).[3] Length 0.81 mm., lemon yellow throughout and with a faint fuscous patch in the fore wings. Reared from *Chrysomphalus aurantii* (Mask.) and *C. citrinus* (Coq.) in Southern California and from *Aspidiotus camelliæ* Sign. and other *Coccidæ* in Peru by E. W. Rust, and from *Chrysomphalus dictyospermi* (Morg.) in Spain by G. Mercet.

Aphelinus semiflavus Howard. Length 1.08 mm., expanse 1.87 mm., eyes of female obscurely hairy, wings short, pale yellow throughout, the legs faintly dusky. Reared[4] from *Chaitophorus viminalis* Monell, *Toxoptera graminum* Rond. and *Myzus persicæ* (Sulzer) in Colorado and from *Rhopalosiphum poæ* Gill. in New Mexico.

Perissopterus mexicanus Howard. Length 0.84 mm., expanse 2.30 mm., pale orange, the entire body and wings curiously spotted with gray or fuscous. Reported in Mexico on *Coccus hesperidum* Linn., *Ceroplastes* sp., and *Pseudococcus* sp. Reared by the writer from *Lecaniodiaspis rufescens* (Ckll.) at Santa Paula, California, and determined by L. O. Howard.

Perissopterus pulchellus (Howard) (*Aphelinus*). Length 1 mm., white, tinged in spots with reddish orange, and spotted with black; wings with a black network. Reported in the east on *Chionaspis pinifoliæ* (Fitch), *Aspidiotus perniciosus* Comst. and reared by the writer from *A. juglans-regiæ* Comst. on cottonwood at Santa Paula, California. Determined by L. O. Howard.

Physcus stanfordi Howard. Length 1.1 mm., expanse 2.07 mm., slender, brown, abdomen with a darker crossband, wings hyaline. Reared from *Dinaspis kelloggi* (Coleman) (*Leucaspis*) on Douglas fir in California.

Physcus varicornis (Howard). Length 0.7 mm., expanse 1.4 mm., shining black, wings hyaline. Occurs throughout the United States and in Sicily and is parasitic on *Chionaspis americana* Johnson, *C. quercus* Comst., *C. furfura* Fitch, *Aspidiotus ancylus* (Putn.), *A. pernicious* Comst., and *A. uvæ* Comst.

Ablerus clisoicampæ (Ashmead) (*Centrodora*). Length 0.7 mm., somewhat metallic black with greenish and bluish reflections, antennæ and legs brown and white, fore wings infuscated with tips clear. Occurs in various parts of the United States on *Chionaspis furfura* (Fitch), *Aulacaspis pentagona* (Targ.), *Aspidiotus perniciosus* Comst., *A. uvæ* Comst., and *A. forbesi* Johnson. It is also recorded from the eggs of *Malacosoma americana* (Fabr.) and *M. disstria* Hbn.

[1] L. O. Howard, *Proc. Biol. Soc. Wash.*, 30, pp. 77–78, 1917.
R. H. Smith, *Research Bul.* 3, Idaho Agr. Exp. Sta., pp. 56–57, 1923.

[2] E. W. Rust, *Ent. News*, 26, pp. 73–74, 1915.
A. B. Gahan, *Proc. U. S. Nat. Mus.*, 65, art. 4, p. 11, 1924.

[3] E. W. Rust, *Ent. News*, 26, p. 75, 1915.
H. J. Quayle, Bul. 222, Cal. Agr. Exp. Sta., p. 131, 1911. Referred to as *A. diaspidis* How.

[4] F. M. Webster and W. J. Phillips, Bul. 110, Bur. Ent. U. S. Dept. Agr., p. 123, 1912.

Aspidiotiphagus citrinus (Craw) (*Coccophagus*) (Figs. 695, 696). Length 0.7 mm., expanse 1.16 mm., pale brownish yellow, antennæ and legs slightly fuscous, middle of all wings with pale infuscated area, darker band frequently across middle of abdomen. A very common and beneficial species occurring in Southern Europe, Brazil, California, and the tropical Pacific Islands. Parasitic on *Aspidiotus ancylus* (Putn.), *A. hederæ* (Vall.), *A. perniciosus* Comst., *A. pini* Comst., *Aulacaspis rosæ* (Bouché), *Diaspis bromeliæ* (Kern), *D. echinocacti* (Bouché), *Lepidosaphes becki* (Newm.), *L. ulmi* (Linn.),

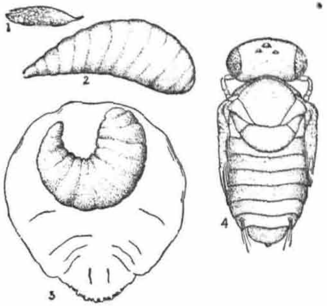

FIG. 695.—The purple scale parasite, *Aspidiotiphagus citrinus* (Craw). 1, egg; 2, larva; 3, larva within body of yellow scale; 4, pupa. (After Quayle.)

Chrysomphalus aurantii (Mask.), *C. citrinus* (Coq.), *C. aonidum* (Linn.), and *C. dictyospermi* (Morg.) in California. It is very common on *Pinnaspis aspidistræ* (Sign.) on coconut palms in the Pacific South Sea Islands.

Encarasia angelica Howard. Length 0.74 mm., expanse 1.7 mm., brownish yellow throughout. Reared from the immature stages of *Aleuroplatus coronatus* (Quaint.) in various parts of California. *Encarsia pergandiella* Howard is a smaller pale yellow species reared by the writer from *Aleuroplatus coronatus* (Quaint.) and from *Trialeurodes*

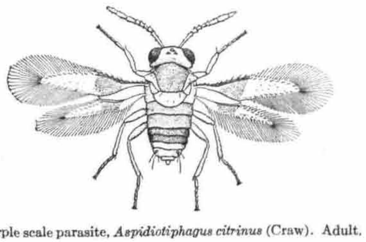

FIG. 696.—The purple scale parasite, *Aspidiotiphagus citrinus* (Craw). Adult. (After Quayle.)

vaporariorum (Westwood) in California. *Encarsia coquilletti* Howard. Length 0.88 mm., wing expanse 1.7 mm., black, the basal half of the wings faintly dusky. Reared from undetermined aleyrodid from sow thistle in Southern California. A number of other species are reported from undetermined *Aleyrodidæ* in the west.

Prospaltella [1] *aurantii* (Howard) (*Coccophagus*, *Prospalta*) (Fig. 697). Length 0.7 mm., expanse 1.16 mm., light brownish yellow, the legs and antennæ dusky. Occurs in China, Australia, Italy, and the United States, and is a common and important parasite of *Kermes nigropunctatus* Ehrh. & Ckll., *Lecanium corni* Bouché, *Aspidiotus juglans-regiæ* Comst., *A. perniciosus* Comst., *A. hederæ* (Vallot), *Lepidosaphes becki* (Newm.), *Chrysomphalus aurantii* (Mask.), *C. citrinus* (Coq.) in California; from *Aspidiotus pini* Comst. in New York; from *A. forbesi* Johnson and *A. howardi* Ckll. in Colorado; and from *Lepidosaphes concolor* (Ckll.) in New Mexico.

Prospaltella citrella Howard. Length 0.72 mm., expanse 1.20 mm., bright lemon yellow, abdomen with broad brown band on middle dorsum. Parasitic on *Kermes* sp. in Arizona. Reared by writer from *Aleuroplatus coronatus* (Quaint.) at Santa Paula California.

Prospaltella quercicola Howard. Length 0.73 mm., expanse 1.53 mm., portions of head and thorax bright yellow, remainder and abdomen blackish, antennæ pale with apical joint dusky, legs pale and brown. Reared from *Aleuroplatus gelatinosus* (Ckll.) and *A. coronatus* (Quaint.) in Southern California.

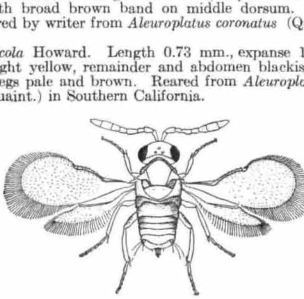

FIG. 697.—The red scale parasite, *Prospaltella aurantii* (Howard). (After Howard.)

Prospaltella peltatus (Cockerell)[2] (*Mimatomus*). Length 0.67 mm., black with bright yellow scutellum suffused with brown at the base, antennæ reddish, hind coxæ brown. Parasitic on *Aleyrodes pruinosa* Bemis *euphorbiara* Ckll. in Colorado.

Coccophagus [3] *albicoxa* Howard. Length 2.60 mm., expanse 5.4 mm. shining black, hind coxæ and portions of the legs whitish. Parasitic on *Physokermes insignicola* (Craw) in California.

Coccophagus californicus Howard. Length 1.4 mm., expanse 2.1 mm., dark brown to nearly black, the mesoscutellum with posterior edge bright yellow. Parasitic on *Icerya purchasi* Mask. and on *Lecanium corni* Bouché in California.

Coccophagus immaculatus Howard. Length 0.90–1.20 mm., expanse 2.35 mm., black, the metascutellum and portions of the legs yellow, males entirely black. Parasitic on *Pulvinaria bigeloviæ* Ckll. in Colorado; *Coccus hesperidum* Linn. and *Saissetia hemisphærica* (Targ.) in California; and *Ericoccus azaleæ* Comst. in the Eastern States.

Coccophagus lecanii (Fitch) (*Platygaster*, *Coccophagus flavoscutellum* Ashm., *C. viridus* How.)[4] (Fig. 698). Length 1 mm., expanse 2.25 mm., shining black, tegulæ brown, posterior half of mesoscutellum and centre of postscutellum bright lemon yellow, tibiæ pale. An important scale parasite occurring throughout the United States and also in Jamaica and Java. It is abundant in California. It attacks the immature stages of the scale insects, there being usually but a single larva in the body of the host. Dark pigmentation of the host follows infestation and the larvæ usually consume the entire tissues before pupating. It sometimes becomes a secondary parasite, in which case only males have been noted as offspring.[5] It has been reared from *Coccus hesperidum* Linn.,

[1] L. O. Howard, "Key to Species of *Prospaltella*," etc. *Ann. Ent. Soc. Am.*, 1, pp. 281–284, 1908.

[2] T. D. A. Cockerell, *Ent. News*, 22, p. 464, 1911.
A. A. Girault, *Ins. Inscit. Mens.*, 4, p. 114, 1916.

[3] L. O. Howard, "A New Species of *Coccophagus* with a Table of Host Relations of Known Species." *Jour. Econ. Ent.*, 4, pp. 276–277, 1911.

[4] The above synonymy was furnished by P. H. Timberlake.

[5] P. H. Timberlake, *Jour. Econ. Ent.*, 6, pp. 298–299, 1913.

C. pseudomagnoliarum (Kuw.), *Pulvinaria vitis* (Linn.), *Pseudococcus citri* (Risso), *Ceroplastes floridensis* Comst., *Lecanium corni* Bouché, *L. persicæ* (Fabr.), *L. pruinosum* Coq., *L. quercitronis* Fitch, *L. quercifex* Fitch, *Saissetia oleæ* (Bern.), *Physokermes insignicola* (Craw), and other *Coccidæ.*

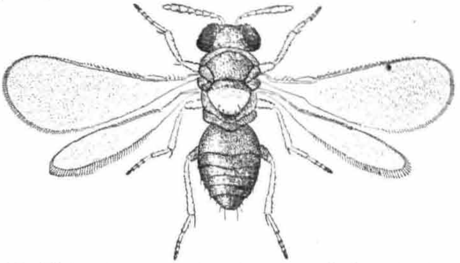

FIG. 698.—The lecanium parasite, *Coccophagus lecanii* (Fitch). (After Howard.)

Coccophagus lunulatus Howard (Fig. 699). Length 0.93 mm., expanse 2 mm., black, apical portions of the mesoscutellum bright orange-yellow with an irregular black spot at the tip, legs amber, the middle and hind coxæ and hind femora black. It attacks the immature stages of the host and never darkens the body as does the preceding species. According to P. H. Timberlake[1] it always avoids the vital organs of the host which often live until after the adult parasite has issued, confines its attacks to the unarmored scales,

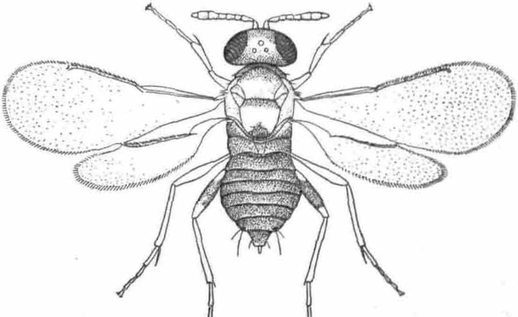

FIG. 699.—The lunulate parasite, *Coccophagus lunulatus* Howard. (After Howard.)

and records from the armored scales are in error. It is always a primary parasite and is common in California on *Coccus hesperidum* Linn., *C. pseudomagnoliarum* (Kuw.), *Lecanium corni* Bouché, and *Saissetia oleæ* (Bern.).

Coccophagus ochraceus Howard. Length 0.7 mm., expanse 1.53 mm., ochraceous or dark amber-yellow throughout. Parasitic on immature stages of *Lecanium corni*

[1] *Jour. Econ. Ent.*, 6, pp. 299–300, 1913.

Bouché and *Saissetia oleæ* (Bern.) in California. It was reared from the latter in great numbers by the writer at Berkeley, California, in October 1922, and determined by A. B. Gahan.

Coccophagus scutatus Howard. Length 1.6 mm., expanse 3.3 mm., black, the mesoscutellum with a broad transverse orange or yellow band clear across. Reared by the writer from *Kermes nigropunctatus* Ehrh. and Ckll. in Southern California and determined by A. B. Gahan. H. Compere has recently described *Coccophagus anthracinus* Compere and *C. trifasciatus* Compere, from *Saissetia oleæ* (Bern.). Both were introduced into Southern California by E. W. Rust and H. S. Smith from South Africa. (H. Compere, Univ. Cal. Pub. Tech. Bul. Ent. 3, pp. 309–312, 1925.)

Eretmocerus californicus Howard. Length 1.5 mm., expanse 1.5 mm., pale yellow throughout. Secondary parasite on *Aleyrodidæ* in Southern California. *E. haldemani* Howard. Length 0.64 mm., expanse 1.78 mm., lemon yellow, antennæ as long as body, club more than four times as long as the pedicle. Secondary on *Aleuroplatus coronatus* (Quaint.) at Berkeley, California.

ENCYRTIDÆ.[1] Encyrtid Parasites.

Anusia neomexicana Ashmead. Length 1.65 mm., iridescent reddish with violet reflections. First recorded from New Mexico. Reared from *Amonostherium lichtensioides* (Ckll.) in Southern California.

Formicencyrtus thoreauini Girault.[2] Length 1.58 mm., ant-like, reddish brown with yellow and white markings, wings scale-like and conspicuous, abdomen with fine white pubescence. Parasitic on *Dactylopius confusus* (Ckll.) in New Mexico.

Anagyrus clauseni Timberlake. Length 1.73 mm., yellow and brownish throughout. Parasitic on *Pseudococcus maritimus* (Ehrh.) at Fresno, California.

Anagyrus subalbicornis (Girault) (*Epidinocarsis*). Length 1.50–1.70 mm., long, slender, dull black with yellow markings, antennæ black with extreme base white. Parasitic on *Pseudococcus maritimus* (Ehrh.) at Fresno, California. It is in turn parasitized by *Achrysopophagus modestus* Timb., *Thysanus elongatus* (Gir.), and *Tetrastichus blepyri* Ashm.

Anagyrus yuccæ (Coquillett) (*Blastothrix*). Length 1.75 mm., very similar to *Blastothrix longipennis* Howard. Reared from *Puto yuccæ* (Coq.) in Southern California.

Acerophagus[3] *citrinus* Howard (*Rhopoideus*). Length 0.55–0.60 mm., wings small, expanse 1.4 mm., pale orange, antennæ faintly dusky, ovipositor sheaths nearly black at tips. Reared from *Aspidiotus perniciosus* Comst. in California.

Acerophagus erii Timberlake. Length 0.7 mm., yellow and orange with black markings, chiefly on the underside. Reared from *Amonostherium lichtensioides* (Ckll.) in Utah.

Acerophagus fasciipennis Timberlake. Length 0.75–0.80 mm., lemon and orange yellow, wings with a smoky band across the disk. Reared from immature stages of *Pseudococcus crawi* (Coq.) in Southern California.

Acerophagus gutierreziæ Timberlake. Length 0.7 mm., pale yellow throughout. Reared from *Pseudococcus gutierreziæ* (Ckll.) in New Mexico.

Acerophagus notativentris (Girault) (*Pseudaphycus*). Length 0.42–0.80 mm., cadmium yellow with blackish brown blotch on the abdomen. Reared from *Pseudococcus maritimus* (Ehrh.) at Fresno, California. Is parasitized by *Thysanus elongatus* (Gir.).

Acerophagus pallidus Timberlake. Length 0.9 mm., uniformly chrome lemon yellow,

[1] L. O. Howard, "Some New *Encyrtinæ*." *Proc. U. S. Nat. Mus.*, 21, pp. 231–248, 1898.

W. H. Ashmead, "Genera of the Subfamily *Encyrtinæ*." *Proc. U. S. Nat. Mus.*, 22, pp. 323–412, 1900.

H. L. Viereck, *Hym. Conn.*, pp. 491–493, 1916.

R. G. Mercet, *Fam. Encirtidos. Fauna Iberica Hym. Inst. Nacional de Ciencias, Museo Nat. de Cien-Naturales*, Madrid, pp. 1–732, 1921.

P. H. Timberlake, "New Genera and Species of *Encyrtinæ* from California Parasitic on Mealybugs." *Univ. Cal. Pub. Tech. Bul. Ent.*, 1, pp. 347–367, 1918.

P. H. Timberlake and C. P. Clausen, "Parasites of *Pseudococcus maritimus* (Ehrh.) in California." *Univ. Cal. Pub. Tech. Bul. Ent.*, 3, pp. 223–292, 1924.

[2] A. A. Girault, *Psyche*, 23, p. 45, 1916.

[3] P. H. Timberlake, Genus *Acerophagus*. *Proc. U. S. Nat. Mus.*, 50, pp. 574–579, 1916.

with apex of ovipositor black and wings hyaline. Reared from *Pseudococcus eriogoni* Ehrh. in Southern California.

Achrysopophagus modestus Timberlake. Length 1.51 mm., brown and yellow, the abdomen iridescent green, wings infuscated at the extreme base. Parasitic on *Zarhopalus corvinus* (Gir.) and *Anagyrus subalbicornis* (Gir.) at Fresno, California.

Stemmatosteres apterus Timberlake.[1] Length 0.5–0.6 mm., ocelli absent, wings abortive, mesonotum reduced, chrome yellow, the antennæ and legs partly dusky. Reared from *Pseudococcus timberlakei* Ckll. on salt marsh grass in the San Francisco Bay region, California.

Pseudococcobius[2] *clauseni* Timberlake. Length 0.8 mm., yellow, brownish, and black. Reared from *Amonostherium lichtensioides* (Ckll.) in Southern California, and from *Eriococcus palustris* Dodds on salt marsh grass in the San Francisco Bay region, California.

Cirrhencyrtus ehrhorni (Timberlake) (*Pseudococcobius*). Length 1–1.1 mm., pale orange yellow. Reared from *Pseudococcus sequoiæ* (Colm.) on Monterey cypress in the San Francisco Bay region, California.

Pseudococcobius fumipennis Timberlake. Length 0.9–1.2 mm., black with white and yellow markings. Reared from *Phenacoccus solani* Ferris in Southern California.

Pseudaphycus[3] *angelicus* (Howard) (*Aphycus*). Length 0.72 mm., orange with dusky markings. Reared from *Pseudococcus maritimus* (Ehrh.), *P. gahani* Green, *P. ryani* (Coq.), *P. longispinus* (Targ.), and *Pseudococcus* spp. in Southern California.

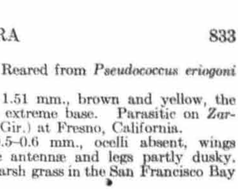

FIG. 700.—*Aphycus lounsburyi* Howard. Eggs before (top) and after (bottom) being deposited. (After Smith and Compere.)

FIG. 701.—*Aphycus lounsburyi* Howard. First-stage larva showing stalk and shield and tracheal system. (After Smith and Compere.)

Ænasioidea[4] *kermicola* Timberlake. Length 0.75–1.25 mm., yellow and white with black markings on the antennæ and dorsum. Reared from *Kermes nigropunctatus* Ehrh. and Ckll. in Southern California and from *K. galliformis* Riley in Utah.

Aphycus[5] *alberti* Howard. Length 0.5–0.9 mm., brownish orange yellow with blackish markings. Occurs in Australia, Hawaii, and Southern California. Commonly

[1] P. H. Timberlake, *Univ. Cal. Pub. Tech. Bul. Ent.*, 1, pp. 352–355, 1918.

[2] P. H. Timberlake, "Genus *Pseudococcobius*." *Proc. U. S. Nat. Mus.*, 50, pp. 563–567, 1916.

[3] P. H. Timberlake, "Genus *Pseudaphycus*." *Proc. U. S. Nat. Mus.*, 50, pp. 569–574, 1916.

[4] P. H. Timberlake, "Genus *Aenasioidea*." *Proc. U. S. Nat. Mus.*, 50, pp. 579, 585, 1916.

[5] P. H. Timberlake, "Revision of the Genus *Aphycus*." *Proc. U. S. Nat. Mus.*, 50, pp. 587–640, 1916.

parasitic on *Coccus hesperidium* Linn. This species has often been confused with *Aphycus flavus* Howard.

Aphycus ceroplastis Howard. Length 1.1–1.4 mm., yellow and brown, scutellum and most of mesopleura blackish. Parasitic on *Ceroplastes irregularis* Ckll. in New Mexico.

Aphycus coquilletti Howard. Length 0.8–0.9 mm., yellow with brown markings, the mesnonotum being wholly blackish brown. Parasitic on *Pulvinaria bigeloviæ* Ckll. in Utah and California.

Aphycus cockerelli Howard. Length 1.28 mm., pale lemon yellow, scape of the antennæ mostly black. Reared from *Lecanium* sp. on osage orange in New Mexico.

Aphycus eriococci Timberlake. Length 0.9 mm., chrome yellow with blackish and white markings, club of antenna with first three joints of the funicle black and the last three white. Parasitic on *Eriococcus quercus* (Comst.) in Utah and California.

Aphycus flavus Howard. Length 0.6–1.2 mm., expanse 2 mm., bright lemon or orange yellow, scape of antenna with small longitudinal dusky streak on upper margin near apex, basal half of club brown. A cosmopolitan species occurring in Southern Europe, South America, and Florida. According to Timberlake it does not occur in California and the many records of it refer to *Aphycus alberti* Howard and more often to *Aphycus luteolus* Timb. It is parasitic on *Coccus hesperidum* Linn., *Saissetia oleæ* (Bern.), and other unarmored *Coccidæ*.

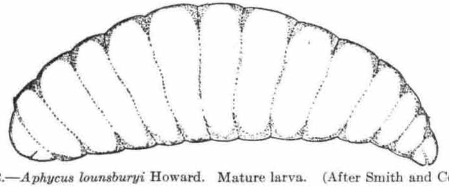

FIG. 702.—*Aphycus lounsburyi* Howard. Mature larva. (After Smith and Compere.)

Aphycus fuscipennis Howard. Length 1.0–1.35 mm., dull black, head and legs pale yellow, wings with a pale band. *Parasitic on Lecanium corni Bouché on manzanita in* Sonoma County, California.

Aphycus howardi Cockerell. Length 1 mm., easily distinguished by its bright scarlet color, antennal club brown, tarsi white, wings with cloud ending at stigmal vein. Parasitic on *Eriococcus tinsleyi* Ckll. in New Mexico.

Aphycus immaculatus Howard. Length 0.55 mm., expanse 1.3 mm., uniform dark and amber or yellowish brown, head paler, antennæ and legs dusky yellow, wings hyaline. According to P. H. Timberlake, the record from *Chrysomphalus aurantii* (Mask.) is probably erroneous. It occurs in Southern California.

Aphycus lecanii Howard. Length 0.7–1.0 mm., blackish brown with orange and yellow colorations, wings with contrasting dark and pale crossbands. A common species in California parasitic on *Lecanium corni* Bouché, *L. quercitronis* Fitch, *L. pubescens* Ehrh., and *Physokermes insignicola* (Craw).

Aphycus lounsburyi Howard [1] (Figs. 700–703). Length 0.7–1.4 mm., expanse 1.6 mm., lemon or orange-yellow with distinct black markings, wings hyaline. The minute translucent white eggs are 0.2 x 0.08 mm., and stalked; the first stage larvæ have a long air stalk, while the full grown forms are 0.3–1.7 mm. long and 0.6–0.9 mm. in diameter, white, tapering towards both ends, and without air stalk. The complete life cycle varies from one to three months. A very important parasite of the half grown black scale, *Saissetia oleæ* (Bern.). It was first known in South Africa, but was introduced into California from Australia by E. J. Vosler and H. S. Smith in 1918. After being reared in the State Insectary, colonies were subsequently distributed in various parts of Southern California where in 1919–1922 the parasite became exceedingly numerous along the coast in the citrus-growing sections, and particularly in Santa Barbara,

[1] H. S. Smith and H. Compere, *Mthly. Bul.*, Cal. State Dept. Agr. 9, pp. 310–320, 1920.

H. S. Smith, *Ibid.*, 10, pp. 127–137, 1921.

Ventura, Los Angeles, and Orange Counties, where the broods of the host are uneven. In many orchards it completely controlled the black scale. Its success has been sadly handicapped by the appearance of several equally efficient secondary parasites, *Quaylea whittieri* (Girault), *Eusemion californicum* Compere, *Tetrastichus blepyri* Ashmead, *Cheiloneurus inimicus* Compere, and others, which have in some cases rendered it almost useless. The mite, *Pediculoides ventricosus* (Newp.), also kills the immature stages in the insectaries. The rearing of great numbers of this parasite by private, coöperative, and county insectaries has enabled the parasite to continue effective in some places. In the warmer interior valleys where the broods of the black scale are even, the parasite cannot well carry through the period between August and February when the scales are too young to permit parasitism.

Aphycus luteolus Timberlake[1] (Fig. 704). Length 0.7–0.8 mm., pale clay yellow marked with brown and black. This species has been commonly and erroneously referred to as *Aphycus flavus* Howard. It is common in California and is parasitic on *Coccus hesperidum* Linn., *C. pseudomagnoliarum* (Kuw.), and *Saissetia oleæ* (Bern.).

Aphycus physokermis Timberlake. Length 0.8–1.5 mm., yellow with brown and black dorsal markings, antennal club yellow, base and preceding joints black. Parasitic on *Physokermes insignicola* (Craw) in California. It is parasitized by *Tetrastichus blepyri* Ashm. and *Cheiloneurus inimicus* Compere.

Aphycus pulvinariæ Howard (*A. californicus* How., *A. oregonensis* How.). Length 0.75–1.10 mm., yellow with black markings. Parasitic on *Pulvinaria vitis* (Linn.) in Utah and Oregon, on *Lecanium corni* Bouché in California, and on *L. nigrofasciatum* Perg. in the east.

Blastothrix longipennis Howard. Length 1.75 mm., expanse 4.15 mm., metallic greenish and bluish black, middle of the antennæ and portions of legs whitish. Reared by writer from *Lecanium corni* Bouché, *L. pruinosum* Coq., and *L. quercitronis* Fitch in California.

Aphidencyrtus aphidiphagus (Ashmead) (*Encyrtus*).[2] Length 1.5 mm., metallic green and blue-black, antennæ brown, legs mostly pale yellow, the femora brown except at tips and the tibiæ with a brown area near the bases. A secondary parasite of *Brevicoryne brassicæ* (Linn.), *Toxoptera graminum* Rond., and other *Aphididæ*, through *Lysiphlebus testaceipes* (Cress.) and *Aphidius* spp. It occurs in various parts of the United States.

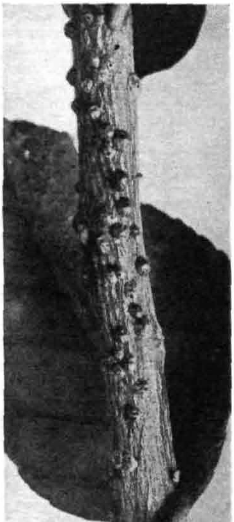

FIG. 703.—Black scale, *Saissetia oleæ* (Bern.), on lemon branch showing exit holes of the adults of *Aphycus lounsburyi* Howard.

Microterys flavus (Howard) (*Encyrtus*)[3] (Figs. 705, 706). Length 0.8–1.2 mm., expanse 3 mm., deep brownish yellow, abdomen with brown spots on the sides of the first two segments, antennæ partly white, front wings with dusky bands and markings. A common species along the coast of Central and Southern California. Parasitic on *Coccus hesperidum* Linn., *Lecanium corni* Bouché, *Saissetia hemisphærica* (Targ.),

[1] H. J. Quayle, Bul. 214, Cal. Agr. Exp. Sta., p. 476, 1911.
H. J. Quayle and E. W. Rust, Bul. 223, Cal. Agr. Exp. Sta., pp. 190, 194, 1911.
P. H. Timberlake, *Jour. Econ. Ent.*, 6, p. 294, 1913.
[2] A. B. Gahan, *Proc. Ent. Soc. Wash.*, 20, p. 66, 1918, and 25, p. 187, 1923.
A. B. Gahan and M. M. Fagan, *U. S. Nat. Mus. Bul.*, 124, p. 14, 1923.
[3] P. H. Timberlake, *Jour. Econ. Ent.*, 6, pp. 295–298, 1913.

Pulvinaria vitis (Linn.), and other *Coccidæ*. It also occurs in the Eastern States. *Microterys mazzanini* Girault has been reared from *Physokermes insignicola* (Craw); and *Microterys titiani* Girault from *Lecanium corni* Bouché in California.

Pseudleptomastix squammulata (Girault) (*Paraleptomastix notatus* Gir.). Length 1 mm., the head dark metallic green, thorax purple, abdomen black, antennæ black,

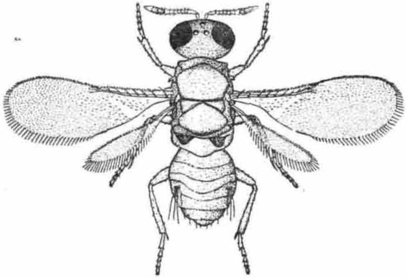

FIG. 704.—*Aphycus luteolus* Timberlake. (After Howard.)

tip of scape yellowish, legs pale yellow with dusky markings on the coxæ and femora. Parasitic on *Pseudococcus maritimus* (Ehrh.) at Fresno, California. It is attacked by the secondaries, *Tetrastichus blepyri* Ashm. and *Thysanus elongatus* (Gir.).

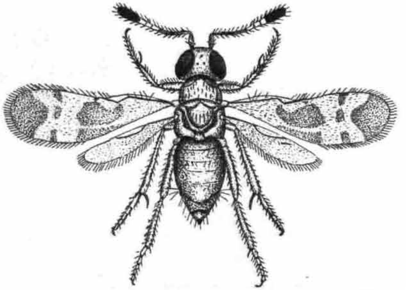

FIG. 705.—The soft brown scale parasite, *Microterys flavus* (Howard).

The Sicilian mealybug parasite, *Leptomastidea abnormis* (Girault) (*Tanaomastix*,[1] *Paraleptomastix*).[2] Length 0.75–1.50 mm., general color golden or dusky yellow, top of head yellow, face white, thorax and abdomen brown and yellow above and white and dusky below, antennæ brown,

[1] P. H. Timberlake, *Univ. Cal. Pub. Tech. Bul. Ent.*, 1, pp. 362–367, 1918.
[2] H. L. Viereck, *Mthly. Bul.*, Cal. State Com. Hort., 4, pp. 208–211, 1915.
H. S. Smith, *Jour. Econ. Ent.*, 10, pp. 262–268, 1917.

legs pale yellow and brown, fore wings with three dark infuscated transverse bands. The adults have the characteristic habit of holding the wings outstretched when walking about. The minute transparent eggs have a short tube at one end. They are inserted into the bodies of the host and hatch in from 3–6 days. The whitish eruciform larvæ live singly in the hosts and mature in 8–25 days. Pupation occurs within the dead skins of the hosts. A complete generation requires from 1–2 months. This interesting and effective parasite was introduced into California from Sicily in 1914 by H. L. Viereck and H. S. Smith and bred up and distributed throughout the State. It is most effective in Southern California where it chiefly attacks the citrus mealybug, *Pseudococcus citri* (Risso), but also parasi-

FIG. 706.—Exit holes of *Microterys flavus* (Howard) in adults of the soft brown scale, *Coccus hesperidum* Linn. (After Quayle.)

tizes *P. krauhniæ* (Kuw.) as well. *Gyranusa claripennis* Timberlake (*Tanaomastix*) is easily separated from the preceding species by the wholly hyaline wings. It has been reared from *Pseudococcus ryani* (Coq.) in Southern California.

Oœncyrtus johnsoni (Howard) (*Encyrtus*). Length 0.8 mm., robust, expanse 2.1 mm., dark metallic green or blackish, antennæ very dark brown, legs pale yellow. Parasitic on the eggs of *Murgantia histrionica* (Hahn) in various parts of the United States. Reared in large numbers from this host, laid on wild bladder-pod growing along the ocean in Southern California.[1]

Zarhopalus[2] *corvinus* (Girault) (*Anargyrella corvina* Gir.).[3] Length 1.15–1.73 mm., dark purplish black, tarsi yellow except the black distal joint. Parasitic on *Pseudococcus maritimus* (Ehrh.) at Fresno, California. It is parasitized by the secondaries, *Achrysopophagus modestus* Timb., *Thysanus elongatus* (Gir.) and *Tetrastichus blepyri* Ashm.

[1] *P. C. Jour. Ent. and Zoöl.*, 14, p. 76, 1922.

[2] P. H. Timberlake, *Univ. Cal. Pub. Tech. Bul. Ent.*, 3, pp. 235–240, 1924.

[3] A. A. Girault, *Jour. N. Y. Ent. Soc.*, 23, p. 169, 1915. Orig. desc.

Zarhopalus sheldoni (Ashm.) is 2 mm. long, dark brown to black with brownish infuscated wings. It has been reared from the same host in Southern California.

Quaylea whittieri (Girault) (*Cerchysius*)[1] (Fig. 707). Length 1–1.3 mm., metallic blue-black, the antennæ and legs largely brown. A very abundant and effective secondary parasite on *Scutellista cyanea* Mots. and *Aphycus lounsburyi* How. in Southern California. It is the chief factor in reducing the efficiency of these two primary parasites.

Homalotylus[2] *affinis* Timberlake. Length 1.39–1.70 mm., ovipositor 0.227 mm., orange and yellow, the antennæ black and white, mesoscutum dark brown to black, front and middle legs yellow, hind legs dark brown or blackish except tarsi, base of femora and coxæ which are yellowish, fore wings with broad dusky crossband. Parasitic on the larvæ and pupæ of *Hyperaspis osculans* Lec. which feeds on *Dactylopius tomentosus* (Lamarck) on opuntia cactus in Southern California. *Homalotylus hyperaspidis* Timberlake is a similar species parasitic on *Hyperaspis undulata* (Say) in Utah, Southern California, and neighboring States.

Homalotylus terminalis (Say) *californicus* Girault (*H. obscurus* How. *californicus* Gir.). Length 1.28-2.26 mm., head metallic dark green or greenish black, remainder of body metallic black with blue and green reflections and with yellow markings, legs and antennæ partly white and yellow, fore wings with broad brownish crossband. Reared from

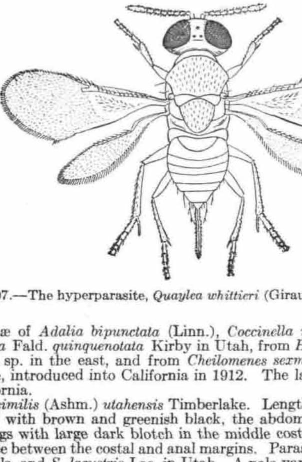

FIG. 707.—The hyperparasite, *Quaylea whittieri* (Girault). (After Quayle.)

larvæ and pupæ of *Adalia bipunctata* (Linn.), *Coccinella novemnotata* Herbst, and *C. transversoguttata* Fald. *quinquenotata* Kirby in Utah, from *Hippodamia convergens* Guér. and *Disonycha* sp. in the east, and from *Cheilomenes sexmaculata* (Fabr.), an oriental ladybird beetle, introduced into California in 1912. The latter has not become established in California.

Anisotylus[3] *similis* (Ashm.) *utahensis* Timberlake. Length 1.35–2.03 mm., yellow and orange marked with brown and greenish black, the abdomen and the notum greenish black, fore wings with large dark blotch in the middle costal region, extending beyond half the distance between the costal and anal margins. Parasitic on the larvæ of *Scymnus americanus* Muls. and *S. lacustris* Lec. in Utah. A pale variety of this species has been reared from larvæ of *Scymnu* sp. at Riverside, California, by P. H. Timberlake.

Isodromus[4] *iceryæ* Howard (*I. pulcher* Gir., *Parataneostigma nigriaxillæ* Gir.). Length 1.70–2.11 mm., bright canary yellow with blackish dorsal markings, wings with small

[1] H. J. Quayle, Bul. 223, Cal. Agr. Exp. Sta., p. 187, 1911. *Cerchysius* sp.
A. A. Girault, *Ent. News*, 29, p. 66, 1918.
P. H. Timberlake, *Proc. Ent. Soc. Hawaii*, 4, p. 214, 1920.

[2] P. H. Timberlake, "Rev. of the Genus *Homalotylus*." *Proc. U. S. Nat. Mus.*, 56, pp. 133–176, 1920.

[3] P. H. Timberlake, *Proc. U. S. Nat. Mus.*, 56, pp. 170–176, 1920.

[4] *Ibid* 56, pp. 176–194, 1920.

dusky spot at the end of the stigmal vein. Reared from the pupæ of *Chrysopa californica* Coq. and *Sympherobius angustus* (Banks) in Southern California. *Isodromus niger* Ashmead. Length 2–2.39 mm., shining metallic black, antennæ brown and black, legs

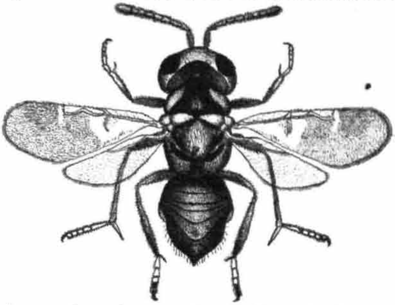

FIG. 708.—The brown apricot scale parasite, *Encyrtus (Eucomys) californicus* Girault (*Comys fusca* Howard).

partly brown, yellow, and whitish. Reared from cocoons of *Chrysopa californica* Coq. and *Sympherobius angustus* (Banks) in Southern California and other insect material in the Eastern States and also in Formosa.

Encyrtus (Eucomys) californicus Girault (*Comys fusca* Howard) (Fig. 708). Parasite of the brown apricot scale. Length 2.6 mm., expanse 5 mm., very dark brown through-

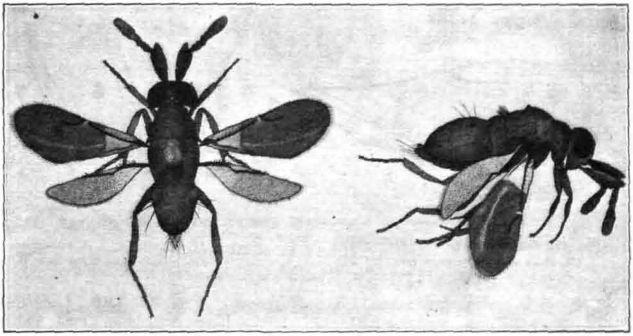

FIG. 709.—The splendid parasite, *Chrysoplatycerus splendens* (Howard).

out, base of fore wings clear, with the apical three-fifths infuscated, legs and antennæ partly yellow. This species is recorded in the east and appears to be indigenous to California being a common and very often an effective parasite of *Lecanium corni* Bouché. It has also been reared from *L. quercitronis* Fitch by the writer.

Bothriothorax[1] *californicus* Howard. Length 1.75 mm., expanse 4.4 mm., metallic blue-green, legs brown with yellow tarsi. Reared from pupæ of *Lasiophthicus pyrastri* (Linn.) in the San Francisco Bay region, California. *Bothriothorax planiformis* Howard (*B. planifrons* D. T.) and *B. rotundiformis* Howard both occur in the Sierra foothills of Central California.

Chalcaspis phenacocci (Ashmead) (*Blepyrus*). Length 1.4 mm., brassy black with greenish reflections, pedicel and club of antennæ and all tarsi except tips yellow. Reared from *Phenacoccus cevalliæ* Ckll. in New Mexico and from *P. solani* Ferris in Southern California.

Cheiloneurus albicornis Howard (*Chiloneurus*). Length 1.8 mm., head reddish, remainder of body black, antennæ brown and white, legs black, brown, and yellow, ovipositor yellow-brown. Parasitic on *Lecanium* spp. and *Kermes* sp. in the east and reared with the pteromalid, *Eunotus lividus* Ashm., from *Pulvinaria vitis* (Linn.) in Colorado.

Cheiloneurus inimicus Compe e. Length 1.6 mm., females dark yellowish with dark green, brownish, and black markings, portions of legs whitish, fore wings partly infuscated, males metallic black with green and coppery reflections, wings hyaline. Parasitic on *Aphycus lounsburyi* How. and *A. physokermis* Timb. in Southern California.

Achrysopophagus dactylopii (Howard) (*Cheiloneurus*). Length 1.92 mm., yellow and brownish, the antennæ white near the middle and dusky or black at tips, the wings hyaline at base and apical three-fifths infuscated. Occurs in various parts of the United States on *Pseudococcus citri* (Risso) and has been reared from *Phenacoccus cevalliæ* Ckll. in New Mexico.

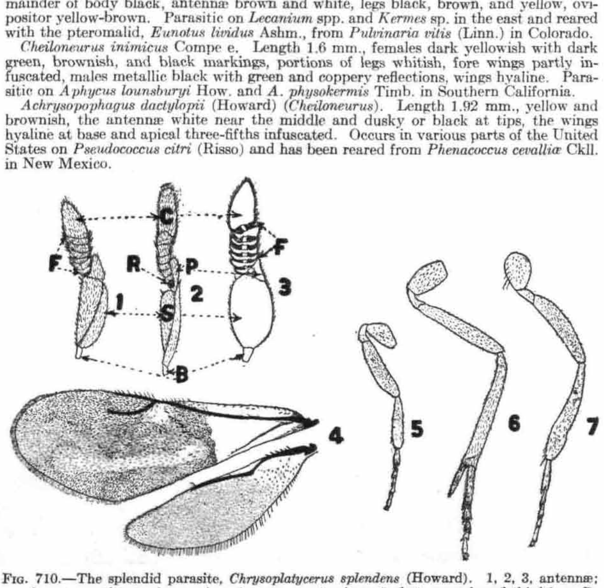

FIG. 710.—The splendid parasite, *Chrysoplatycerus splendens* (Howard). 1, 2, 3, antennæ; 3, cross section to show union of segments; 4, wings; 5, first, second, and third legs; B, bulb; C, club; F, funicle; P, pedicel; R, ring joints; S, scape.

Chrysoplatycerus[2] *splendens* (Howard) (*Rileya*)[3] (Figs. 709, 710). Length of female 2.1 mm., expanse 1.93 mm., metallic black with blue, green, and purple reflections, the scutellum lustrous green, apical two-thirds of fore

[1] L. O. Howard, "Bothriothoracine Insects of U. S." *Proc. U. S. Nat. Mus.*, 17, pp. 605–613, 1894.

[2] P. H. Timberlake, "Rev. of the Genus *Chrysoplatycerus*." *Proc. U. S. Nat. Mus.*, 61, art. 2, pp. 1–10, 1922.

[3] E. O. Essig, *P. C. Jour. Ent.*, 3, pp. 521–522, 1911.

wings infuscated, tarsi and middle femora reddish, antennæ very large. The males are similar in color, antennæ much more slender, wings shorter and wider than those of the female, entirely hyaline. This species appears to be indigenous to Southern California where it is parasitic on *Pseudococcus citri* (Risso), *P. maritimus* (Ehrh.), and *P. ryani* (Coq.). *Chrysoplatycerus ferrisi* Timberlake is separated from the preceding species by the reddish orange or brownish head and prothorax. It is parasitic on *Pseudococcus adenostomæ* Ferris at San Diego, California. Both of these parasites are attacked by the secondary, *Tetrastichus blepyri* Ashm.

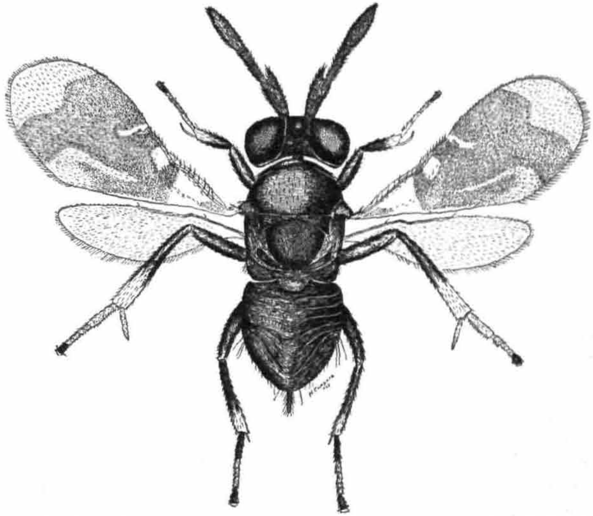

FIG. 711.—The California hyperparasite, *Eusemion californicum* Compere. (After Compere.)

Eusemion californicum Compere[1] (Fig. 711). Length 1.1-1.7 mm., metallic black with blue, green, purple, and cupreous reflections, portions of legs yellowish, fore wings infuscated with the bases hyaline. A common and effective parasite on *Aphycus lounsburyi* Howard in Southern California. *Eusemion longipenne* (Ashm.)[2] is distinguished from the above by the absence of the band of silvery hairs in front of the eyes. It is parasitic on *Microterys flavus* (How.) and on *Aphycus flavus* Howard in Southern California. It was described from Florida.

[1] H. Compere, *Univ. Cal. Pub. Tech. Bul. Ent.*, 3, pp. 304–308, 1925.
[2] P. H. Timberlake, *Jour. Econ. Ent.*, 6, pp. 301–303, 1913.

Hunterellus hookeri Howard.[1] Length 0.85 mm., expanse 2.04 mm., shining black, antennæ fuscous, legs brown and yellow, wings hyaline. Originally described from the tick, *Rhipicephalus texanus* Banks, in Texas and subsequently taken from *Dermacentor parumapertus* Neum. *marginatus* Banks on jackrabbit and dog in Green Valley, California, by H. P. Wood.[2]

SIGNIPHORIDÆ.[3] Signiphorid Parasites.

Signiphora aleyrodis Ashmead. Length 0.5 mm., mostly golden yellow, brown basal band on abdomen, scape of the antennæ entirely yellow. Recorded in various parts of North and South America on *Aleyrodes* sp. and on *Aspidiotus camelliæ* Sign., *Chrysomphalus aonidum* (Linn.), *C. dictyospermi* (Morg.), and *Lepidosaphes carinata* (Ckll.). Reared from immature stages of *Aleuroplatus coronatus* (Quaint.) in Southern California.

Signiphora coquilletti Ashmead. Length 0.5 mm., bright golden yellow, dark brown blotch on basal third of the abdomen, club of antennæ wholly yellow. Parasitic on *Aleuroplatus coronatus* (Quaint.), *A. gelatinosus* (Ckll.), and *Aspidiotus* sp., in California and Mexico.

The yellow-cloaked chalcid, *Signiphora flavopalliata* Ashmead *occidentalis* Howard[4] (Fig. 712). Length 0.53 mm., expanse 1.2 mm., brown, sides and venter of thorax yellowish, wings with dusky band beneath the marginal vein. Distributed throughout

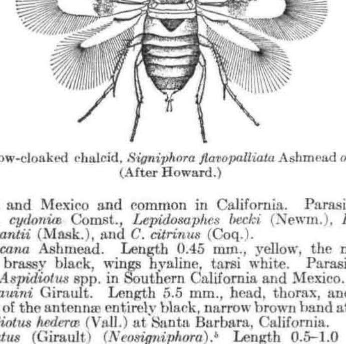

FIG. 712.—The yellow-cloaked chalcid, *Signiphora flavopalliata* Ashmead *occidentalis* Howard. (After Howard.)

the United States and Mexico and common in California. Parasitic on *Aspidiotus camelliæ* Sign., *A. cydoniæ* Comst., *Lepidosaphes becki* (Newm.), *L. gloveri* (Pack.), *Chrysomphalus aurantii* (Mask.), and *C. citrinus* (Coq.).

Signiphora mexicana Ashmead. Length 0.45 mm., yellow, the mesonotum brown and the abdomen brassy black, wings hyaline, tarsi white. Parasitic on *Aspidiotus hederæ* (Vall.) and *Aspidiotus* spp. in Southern California and Mexico.

Signiphora thoreauini Girault. Length 5.5 mm., head, thorax, and most of the addomen yellow, club of the antennæ entirely black, narrow brown band at base of abdomen. Reared from *Aspidiotus hederæ* (Vall.) at Santa Barbara, California.

Thysanus elongatus (Girault) (*Neosigniphora*).[5] Length 0.5–1.0 mm., black, legs black and brownish, the tarsi yellow and fuscous, fore wings with a cross band opposite the stigmal vein. Common in California and secondary through the primary parasites, *Acerophagus notativentris* (Girault) *Pseudleptomastix squammulata* (Gir.), *Zarhoplaus corvinus* (Gir.), and *Anagyrus subalbicornis* (Gir.) and tertitary through *Achrysopophagus modestus* Timb. and *Tetrastichus blepyri* Ashm., all on *Pseudococcus maritimus* (Ehrh.).

[1] L. O. Howard, *Can. Ent.*, 40, pp. 239–241, 1908.
[2] *Jour. Econ. Ent.*, 4, p. 425, 1911.
[3] W. H. Ashmead, *Proc. U. S. Nat. Mus.*, 22, pp. 409–412, 1900.
A. A. Girault, "Mon. *Signiphorinæ*." *Proc. U. S. Nat. Mus.*, 45, pp. 189–233, 1913.
[4] A. A. Girault, *Psyche*, 23, p. 41, 1916.
[5] *Ibid.*
P. H. Timberlake and C. P. Clausen, *Univ. Cal. Pub. Tech. Bul.* 3, pp. 246–248, 281–284, 1924.

Thysanus nigra (Ashmead) (*Signiphora*). Length 5.5 mm., wholly shining black, middle and front tibiæ brown, tarsi white, basal half of wings infuscated. Recorded on *Aspidiotus perniciosus* Comst. in New York and on *Coccus hesperidum* Linn. in California.

EUPELMIDÆ.[1] Eupelmid Parasites.

Anastatus ruficollis (Cameron) (*Bephrata*, *Brasema*) (Fig. 713). Length 6–7 mm., abdomen compressed laterally, reddish, antennal segments 6–9, the meso- and metanotum and dorsum of the abdomen black, wings yellowish except at base. A very common parasite on the eggs of *Microcentrum rhombifolium* (Sauss.) in California. The species was described from Panama. It has generally been erroneously identified as *Anastatus mirabilis* (Walsh) (*Eupelmus*) in the past in California.

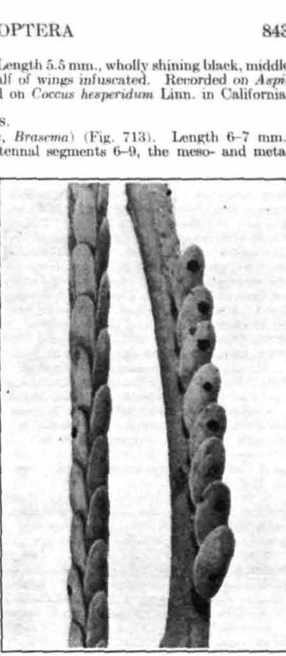

FIG. 713.—The katydid egg parasite, *Anastatus ruficollis* Cameron. Exit holes of adults in eggs of the angular-winged katydid, *Microcentrum rhombifolium* (Sauss.).

Anastatus semiflavidus Gahan.[2] Length 2.3–2.5 mm., brassy green, yellow, and brown, the fore wings of the female with a median and apical dusky band, those of the male hyaline. An effective parasite on the eggs of *Hemileuca oliviæ* Ckll. in New Mexico.

Arachnophaga picea (Howard) [*Eupelmus piceus* (Riley) Howard]. Length 3.1 mm., metallic black with bronze and brassy reflections. Reared from eggs of the spiders, *Argiope argentata* (Fabr.) and *Phidippus orpifex* (McCook) in Southern California.

Ptinobius agrili Rohwer. Length 2.5–4.25 mm., metallic bronzy green with purplish reflections, antennæ reddish, the apical joint black, legs reddish except green spot on the exterior tips of the hind femora, fore wings with dusky spot at end of marginal vein and a wide dusky band in the middle. Reared from twigs of live oak infested with *Agrilus angelicus* Horn in Central and Southern California.

Eusandalum coquilletti (Ashmead) (*Ratzeburgia*). Length 4.5–5 mm., black and bronzy green, legs reddish and yellow, fore wings with a dark band beneath marginal vein. Reared from the immature stages of *Œme gracilis* Lec. in Southern California.

Tanaostigmodes tychii Ashmead. Length 2.5 mm., black, the appendages and abdomen amber or brownish yellow, wings hyaline. Parasitic on *Tychius semisquamosus* Lec. in Southern California.

CALLIMOMIDÆ (*Torymidæ*).[3] Callimomid Parasites.

Eridontomerus isosomatis (Riley) (*Stictonotus*, *Merisus*, *Semiotellus*). Length 3.25 mm., metallic green, antennæ black, club brownish, legs partly green and yellow, body

[1] W. H. Ashmead, Key to Genera. *Proc. Ent. Soc. Wash.*, 14, pp. 4–20, 1896.
H. L. Viereck, *Hym. Conn.*, pp. 507–508, 1916.
C. M. Packard, "Life History of *Eupelmus allyni* (French)." *Jour. Agr. Research*, **6**, pp. 370–373, 1916.
Also W. J. Phillips and F. W. Poos, *Ibid.*, 21, pp. 420–426, 1921.

[2] D. J. Caffrey, Biology. *Jour. Agr. Research*, 21, pp. 373–384, 1921.

[3] H. L. Viereck, *Hym. Conn.*, p. 512, 1916.
A. B. Gahan, *Proc. Ent. Soc. Wash.*, 22, pp. 235–238, 1920.

covered with white hairs. Occurs throughout the country. Parasitic on *Harmolita grandis* (Riley).

The members of the genus *Megastigmus* [1] are small black, yellow, or a combination of these colors, the larvæ of which feed in seeds and are therefore more or less destructive. *M. albifrons* Walker is 5 mm. long, has the ovipositor longer than the body, fore wings with brown spot, black and yellow. Reared from seeds of yellow pine at Placerville, California. *M. lasiocarpæ* Crosby is 3.7 mm., ovipositor 3 mm., abdomen 1.5 mm., stigma without clouded area, black and yellow, the pronotum without yellow spots. Reared from seeds of alpine or balsam fir in Colorado. *M. picea* Rohwer. Length 2.5 mm., ovipositor 2 mm., black with yellow markings. Reared from seeds of Engelmann spruce and Colorado blue spruce in Colorado, and from Sitka spruce in Northern California. *M. pinus* Parfitt. Length 4–5 mm., abdomen 2.3 mm., ovipositor 5–5.5 mm., black with orange markings, pronotum with large reddish orange area. Occurs in Russia in seeds of mountain ash. Reared from seeds of amabilis fir, noble fir, white fir, bristlecone fir, grand fir, and red cedar in the Sierras of California, Nevada, and Oregon. *M. spermotrophus* Wachtl. Length 3–3.5 mm., abdomen 1.8 mm., ovipositor 1.6 mm., yellowish brown. Occurs in Colorado, Nevada, California, Oregon, and Washington, and has been reared from seeds of Douglas fir, amabilis fir, bristlecone fir, grand fir, red fir, white fir, Hooker hemlock, and other conifers. *M. tsugæ* Crosby. Length 2.5 mm., abdomen 1.1 mm., ovipositor 1.8 mm., yellow and black, pronotum with two yellow spots. Reared from mountain hemlock in Western States.

Monodontomerus montivagus Ashmead. Length 4.5–5 mm., brassy green and black, the legs mostly reddish. Reared from the larvæ of *Anthidium emarginatum* (Say) in Colorado and Southern California, and from *Xylocopa orpifex* Smith in Southern California.

Callimome anthidii (Ashmead) (*Torymus*) is parasitic on *Anthidium consimile* Ashmead in Southern California. *Callimome bedeguaris* (Linn.) (*Torymus magnificus* O. S.). Length 3.5–4 mm., ovipositor 5–6 mm., metallic green, blue with coppery and purplish iridescence. Reared from galls of *Diplolepis bicolor* (Harris) and *D. radicum* (O. S.); and *Callimome chrysochlora* (O. S.), from the galls of *Diplolepis fusiformans* (Ashm.) in Colorado.

Syntomaspis californica Ashmead. Length 2.5–3 mm., ovipositor 4–6 mm., iridescent golden green, antennæ black, legs reddish, abdomen coppery, ovipositor black. Reared from galls of *Andricus lasius* (Ashm.), *A. pomiformis* (Bass.), *A. agrifoliæ* (Bassett), and *Disholcaspis corallina* (Bass.) in California.

Syntomaspis cærulea Fullaway. Length 1–2 mm., ovipositor as long as the body, males half as large as females, bright metallic green often with brassy and coppery iridescence, tibiæ and tarsi pale. Reared by writer from galls of *Andricus agrifoliæ* (Bass.) and *A. bicornis* (McC. & Egbert) at Berkeley, California. A number of species of *Syntomaspis* are recorded from Colorado without definite host records.

Liodontomerus insuetus Gahan. Length 1.5 mm., ovipositor as long as the body, brassy green and bronze. Reared from *Bruchophagus funebris* How. in Arizona. The larvæ feed externally on the host. *L. perplexus* Gahan. Length 1.6–1.8 mm., ovipositor two-thirds as long as body, brassy green and bronze. Reared from *Bruchophagus funebris* How. in Arizona. *L. secundus* Gahan. Length 1.7 mm., very similar to the preceding species and separated by a fuscous spot in the fore wing. Reared from *Bruchophagus funebris* How. in Idaho.

Pseuderimerus mayetiolæ Gahan. Length 1.5–1.8 mm., metallic coppery brass, legs partly reddish, ovipositor sheaths black. Parasitic on *Phytophaga destructor* (Say) in Alameda County, California.

EURYTOMIDÆ.[2] Eurytomid Wasps.

Decatomidea cooki Howard. Length 3.6 mm., expanse 5.8 mm., head, pronotum, and mesonotum densely and coarsely punctate; yellow and black, antennæ yellow, all legs yellow except the dark hind coxæ, abdomen with black dorsal spots. Reared from seeds of wild grape in Michigan and in California. It also occurs in Europe.

[1] C. R. Crosby, *Seed Infesting Chalcis-flies*. Bul. 265, Cornell Agr. Exp. Sta., pp. 367–388, 1909. "Rev. N. A. Species of *Megastigmus*." *Ann. Ent. Soc. Am.*, 6, pp. 155–170, 1913. Placed in the Family *Torymidæ* by Crosby.
S. A. Rohwer, "Chalcids Inj. to Forest Trees." *Tech. Ser.* 20, pt. 6, Bur. Ent. U. S. Dept. Agr. 1913.

[2] H. L. Viereck, *Hym. Conn.*, pp. 517–524, 1916.

The clover seed chalcis, *Bruchophagus funebris* Howard,[1] (Fig. 714). Length 1.7 mm. black, all tarsi and portion of front tibiæ pale brown, eggs polished white, larvæ white, just filling the seed. The eggs are inserted into the developing seeds of alfalfa and clover which are destroyed by the larvæ. Pupation also occurs within the seeds. From three

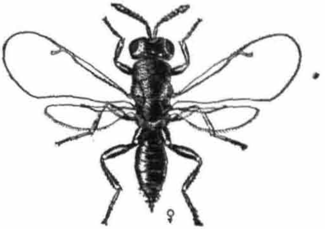

FIG. 714.—The clover seed chalcis, *Bruchophagus funebris* Howard. (After Howard.)

to five generations occur annually. This very injurious pest occurs throughout North America and annually destroys from 10 to 75 per cent of the seed crop. In the west it is injurious in every State, and in British Columbia. Wild clovers may act as breeding places. Cutting for hay so as to produce seed either very early or late gives best control. *Bruchophagus mexicanus* Ashm. occurs in New Mexico.

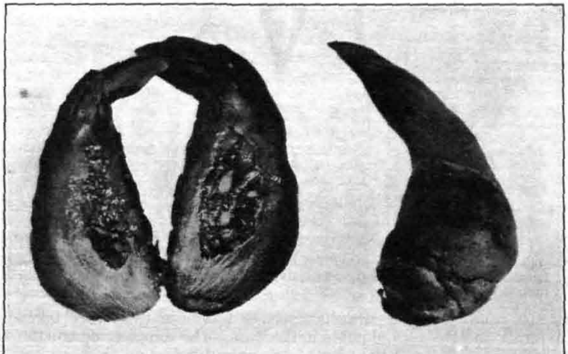

FIG. 715.—The larvæ of the cattelya fly or orchid isosoma, *Eurytoma orchidearum* (Westwood). (After L. A. Whitney.)

Eurytoma californica Ashmead. Length 3–6 mm., black, portions of the body covered with white or brown hairs, legs partly brown, wings hyaline. Reared from galls of *Andricus pomiformis* (Bassett) along with *Tetrastichus californicus* Ashm. in Southern California.

[1] C. V. Piper and R. McKee, *Farmers' Bul.*, 693, U. S. Dept. Agr. 1915.
T. D. Urbahns, *Jour. Agr. Research*, 7, pp. 147–153, 1916.

Eurytoma bromi (Howard) (*Isosoma*). Length 3.4 mm., expanse 5.6 mm., black, head and thorax densely punctate, abdomen smooth. It feeds in stems of fringed brome grass in Southern California.

The cattleya fly or orchid isosoma, *Eurytoma orchidearum* (Westwood) (*Isosoma*).[1] (Figs. 715, 716). Length 4.5 mm., black. The small white legless larvæ attain a length of 6 mm., feed in the bulbs, stems, leaves, and buds of many kinds of orchids and are serious pests in greenhouses through-

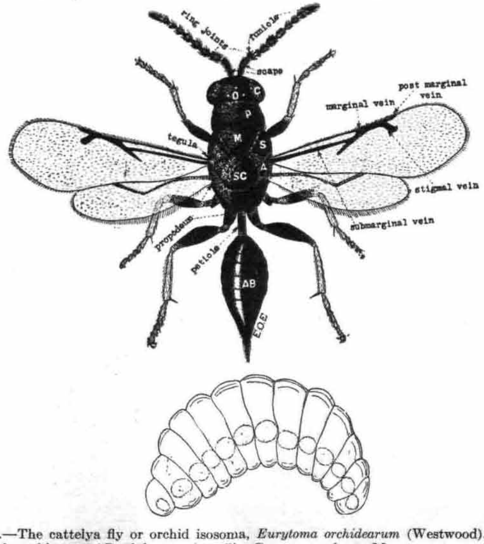

FIG. 716.—The cattelya fly or orchid isosoma, *Eurytoma orchidearum* (Westwood). Adult female and larva. AB, abdomen; A, axilla; C, compound eye; M, mesonotum or præscutum; O, ocelli; P, pronotum; S, scapula; SC, scutel.

out the country. This Brazilian species has been frequently taken in California and British Columbia in the west. The complete destruction of the infested portions of the plants or vacuum fumigation are necessary to control this pest.

Harmolita californica (Howard) (*Isosoma*).[2] Length 5 mm., black with yellow legs. It feeds in stems of wild grass in the Santa Cruz mountains, California.

[1] L. A. Whitney, *Mthly. Bul.*, Cal. State Com. Hort. 3, pp. 483–485, 1914.

[2] This species is listed from Indian millet, *Eriocoma cuspidata* (Nutt.), a desert or semi-arid grass which does not occur in the Santa Cruz mountains in California. It may be that the material was collected elsewhere in California or in Arizona.

The wheat straw worm, *Harmolita* [1] *grandis* (Riley) (*Isosoma grande* Riley, *Isosoma tritici* Riley)[2] (Fig. 717), is the most widely distributed, destructive, and best known member of the genus. It is further distinguished by having an alternation of generations. According to Doane [3] the small greenish yellow larvæ infest the stems of wheat during the summer and fall usually near the joints. They attain a length of 6 mm. Pupation begins in September and lasts until January. Adults of the first generation begin to appear in the Western States about the first of February. They are of the form *minuta* (Riley) and are small, black, wingless, ant-like insects 2.8 mm. long, and are of both sexes. The females oviposit in the heart of the young plant and the larvæ work within the short stem and soon destroy the developing head. The larvæ of this generation are most injurious. If the plants are not killed outright, the largest stalk is destroyed and the weaker side stools produce a poor crop. Maturity is reached in a month and by the first of March the adults of the second generation appear. These are of the form *grandis* (Riley) and are all black, fully winged females, which average 4.2 mm. in length and have an expanse of 7.6 mm. They differ from other species by the smooth polished and shining mesothorax. They constitute the summer migrating forms and scatter over a considerable range. They oviposit in the largest and most vigorous plants and the larvæ hibernate in the straw and stubble in the field. If the larvæ of this generation develop in young plants, the injury is the same as produced by those of the spring brood, but if they have only old plants to attack, the injury is slight. This species occurs throughout North America and is found wherever wheat is extensively grown. In the west it is well known in Utah, Idaho, California, Oregon, and Washington. Inasmuch as the winter is spent by the larvæ in the stubble and straw it is impor-

FIG. 717.—The wheat straw worm, *Harmolita grandis* (Riley) form *minuta* (Riley). Adult female climbing a wheat straw. (Photo by S. B. Doten.)

[1] W. J. Phillips and W. T. Emery, "Rev. of the Genus *Harmolita* of Am. North of Mexico." *Proc. U. S. Nat. Mus.*, 55, pp. 433–471, 1919.
A. B. Gahan, *Proc. Ent. Soc. Wash.*, 22, p. 236, 1921.

[2] C. V. Riley, *Bul. Brooklyn Ent. Soc.*, 7, pp. 111–112, 1884. Also *Am. Nat.*, p. 247. March, 1882.
F. M. Webster, *Circ.* 106, Bur. Ent. U. S. Dept. Agr., p. 8, 1909.

[3] R. W. Doane, *Mthly. Bul.*, Cal. State Dept. Agr., 5, pp. 69–72, 1916.

tant to burn over the fields after harvest, to plow deeply, or to rotate crops in order to secure control.

The wheat joint worm, *Harmolita tritici* (Fitch) (*Eurytoma*, *Isosoma*, *I. nigrum* Cook), is a similar species, with both sexes winged. The larvæ produce hard enlargements at the second or third joint from the base of the plant or on all the joints. The pest occurs throughout the east on wheat and is recorded from California on grass. For control see the preceding species.

The wheat sheath worm, *Harmolita vaginicola* (Doane) (*Isosoma vaginicolum* Doane)[1] (Fig. 718). Length 3 mm., shining black, thorax dull black,

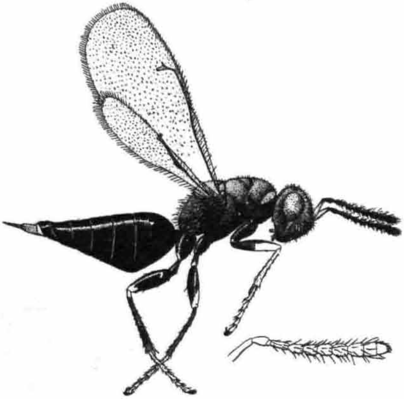

FIG. 718.—The wheat sheath worm, *Harmolita vaginicola* (Doane). Adult female and antenna. (After Doane.)

body and appendages with yellow markings. The work of the larvæ resembles that of the preceding species but the swelling occurs only in the leaf sheaths which often become distorted. Wheat is the only recorded host. The males are unknown. This species occurs only in the dry farming regions of Utah in the west, but is recorded also in Ohio. For control see the wheat straw worm. Sowing before the first of October is recommended in the east.

Harmolita websteri (Howard) (*Eurytoma hordei* Fitch, *Isosoma hirtifrons* How., *I. fitchi* How.). Length 3.7 mm., expanse 7 mm., abdomen of the female equal to or longer than head and thorax combined. Occurs throughout the United States in the stems of rye, and in California in rye and wheat.

Harmolita agropyrocola Phillips and Emery has been reared from the stems of *Agropyron* sp. in Utah. *H. occidentalis* Phillips and Emery makes inconspicuous galls in the

[1] R. W. Doane, *Jour. Econ. Ent.*, 9, pp. 398–401, 1916.

stems of *Agropyron* sp. in New Mexico. *H. agrostidis* (Howard) (*Isosoma*) occurs on *Agrostis* sp. in Placer County, California. *H. bromicola* (Howard) (*Isosoma*) has been reared from fringed brome grass in Southern California. *H. elymophila* Phillips and Emery forms small galls on the stems of wild rye in California. *H. elymoxena* Phillips and Emery also attacks the same host in California. *H. hesperus* Phillips and Emery forms small galls on wild rye in Utah. *H. rufipes* Phillips and Emery forms galls in the internodes of the stems just below the head of wild rye in Utah and New Mexico. *H. poophila* Phillips and Emery produces galls on the stems of meadow grass in Colorado.

Euchrysia hyalinipennis Ashmead.[1] Length 4 mm., metallic bronzy black with blue and green iridescence and white pubescence. Recorded in Missouri and Texas and reared from *Chrysobothris deleta* Lec. in California.

PERILAMPIDÆ.[2] Perilampids.

These are small secondary parasites on the hymenopterous and dipterous primary parasites, on ants, and probably on other insects, while a few are recorded as gall makers in Australia and other countries. The very young larvæ or planidia are microscopic in size or about 0.3 mm. long, flat, 13-segmented, obovate in shape, dark brown with well developed mouth hooks, many body spines ventrally and a few posteriorly, and two rather long oval stylets. They attach themselves directly and feed externally upon the immediate host or primary parasite or they may first enter the body cavity of the caterpillar, chrysopid larvæ, or other host of the primary parasite and there attack the latter or immediate host. Many of the host relationships are not yet known. The admirable study of the life history of *Perilampus hyalinus* Say by H. S. Smith serves to indicate the complex nature of the workings of these little known insects. This species is recorded from Arizona in the west.

Perilampus chrysopæ Crawford is iridescent green, the legs and antennæ with reddish markings, and the length 2 mm. This species and the var. *lævicephalus* Crawford have been reared as primary parasites on the larvæ and pupæ of *Chrysopa californica* Coq., *Sympherobius angustus* (Banks) and related species in California and probably occurs in other Western States where the hosts abound. *Perilampus anomocerus* Crawford, *P. bakeri* Crawford, *P. platygaster* Say, and *P. similis* Crawford occur in Colorado; *P. cyaneus* Brullé, in Arizona; *P. subcarinatus* Crawford, in Southern California; *Euperilampus opacus* Ashmead, in Arizona and Colorado; *Chrysolampus parcipunctatus* Crawford, in Southern California; *C. schwarzi* Crawford, in Utah.

CHALCIDIDÆ.[3] Chalcids.

Brachymeria abiesiæ (Girault) (*Chalcis*) (Fig. 719). Length 3-7 mm., black and yellow, hind femora greatly enlarged for jumping. Reared from the pupæ of *Phryganidia californica* Pack. and *Malacosoma californica* (Packard), in California. This species can easily be mistaken for *Brachymeria ovata* (Say).

The common chalcid, *Brachymeria ovata* (Say) (*Chalcis annulipes* Walker, *C. incerta* Cress.). Length 3.5-7 mm., robust, black and yellow, femora

[1] This genus belongs to the family *Cleonymidæ* in Ashmead's classification.

[2] H. S. Smith, "The Chalcidoid Genus *Perilampus* and its Relation to the Problem of Parasite Introduction." *Tech. Ser.* 19, pt. 4, Bur. Ent. U. S. Dept. Agr. 1912.

J. C. Crawford, "Species of American *Perilampidæ* North of Mexico." *Proc. Ent. Soc. Wash.*, 16, pp. 69–76, 1914.

[3] L. O. Howard, "Biology of the Insects of the Family *Chalcididæ*." *Proc. U. S. Nat. Mus.*, 14, pp. 567–588, 1892.

W. H. Ashmead, "Class of the Chalcid Flies." *Mem. Carnegie Mus.*, 1, 1904.

Otto Schmiedeknecht, *Genera Insectorum. Fasc.*, 97, pp. 1–550, 1909.

A. B. Gahan, Bul. 124, U. S. Nat. Mus., pp. 24, 31, 1923.

black with white or yellow spot near the tips, tegulæ white or yellow. A very common species throughout North America and an important parasite of the pupæ of *Papilio zelicaon* Lucas (California), *Agalis californica* (Bdv.) (California), *Dione vanillæ* (Linn.) (Eastern U. S.), *Chlorippe clyton* (Bdv.

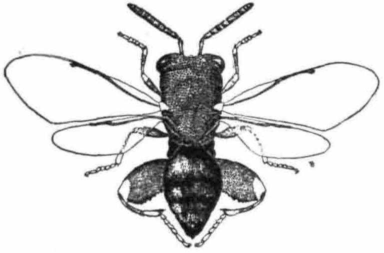

FIG. 719.—The black and yellow chalcid, *Brachymeria abiesiæ* (Girault). Adult. (After Burke and Herbert, U. S. Dept. Agr.)

& Lec.) (Eastern U. S.), *Eurymus eurytheme* (Bdv.) (California and Arizona), *Hemerocampa leucostigma* (A. & S.) (Eastern U. S.), *H. vetusta* (Bdv.) (California), *H. oslari* (Barnes) (California), *Phryganidia californica* Pack. (California), *Archips argyrospila* Walker (California), *A. rosaceana* (Harris) (New Mexico), *Hemileuca oliviæ* Ckll. (New Mexico), *Alabama argillacea* (Hbn.) (Eastern U. S.), *Anacampsis fragariella* Busck (California), and other *Lepidoptera*.

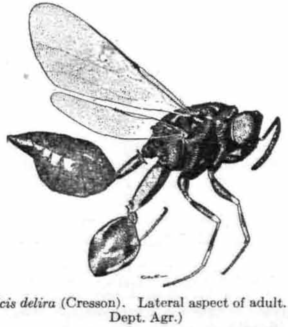

FIG. 720.—*Spilochalcis delira* (Cresson). Lateral aspect of adult. (After Marsh, U. S Dept. Agr.)

Spilochalcis delira (Cresson) (*Smicra*) (Fig. 720). Length 2.5 mm., black, with yellow spots, portions of antennæ brown, legs partly yellow, abdomen reddish at the base and apex. Reared from *Plutella maculipennis* Curtis in Colorado, and secondary on the primary, *Angitia polynesialis* (Cameron).

Spilochalcis flavopicta (Cresson) (*Smicra*). Length 2–3 mm., black with yellow and white spots and markings, hind femora armed beneath with row of small spines. Reared with *Brachymeria ovata* (Say) from *Anacampsis fragariella* Busck in Northern California by the writer.

Spilochalcis torvina (Cresson) (*Smicra*). Length 4–5 mm., opaque black with yellow and orange spots and markings. Secondary on *Hulstia undulatella* Clemens in Southern California and in Arizona.

Trigonura californica Rohwer. Length 7 mm., black, pubescent, legs partially red, sides of abdomen red. Reared from larvæ of *Chrysobothris mali* Horn at Placerville, California.

PROCTOTRUPOIDEA (*SERPHOIDEA*)[1] (Superfamily)

Proctotrupid Parasites or Pointed-Tailed Wasps

This superfamily comprises small, slender, pointed-tailed insects which are mostly primary and secondary parasites on other insects.

KEY TO FAMILIES[2]

1. Hind metatarsi one-fourth the length of the following segment. Large insects; the abdomen of the female filiform and several times the length of the head and thorax together; that of the male long and clavate .... **Pelecinidæ**
   Hind metatarsi at least as long as the following segment. Small insects 2

2. Mandibles in a reversed position, their apices directed outwardly, away from the mouth opening .... **Vanhorniidæ**
   Mandibles in a normal position 3

3. Cells Cu + Cu_1 and M_3 of the fore wings fully enclosed and separated from each other by perfect veins 4
   Cells Cu + Cu_1 and M_3 of the fore wings partly enclosed by brown lines, or altogether wanting; claws not pectinate 5

4. Cell M_4 of the fore wings triangular; antennæ composed of sixteen segments; mandibles with teeth .... **Heloridæ**
   Cell M_4 of the fore wings irregularly six-sided; antennæ composed of fourteen segments .... **Roproniidæ**

5. Abdomen sharply margined by a carina along the sides; antennæ arising near the clypeus 6
   Abdomen immargined laterally (acute in *Telenominæ*, but without a carina) .. 7

6. Antennæ with never more than ten segments, rarely with only eight or nine; labial palpi with one segment .... **Platygasteridæ** p. 852
   Antennæ usually with twelve segments, more rarely with eleven, or if with seven or eight segments the club is unsegmented; labial palpi with two or more segments .... **Scelionidæ** p. 852

[1] L. O. Howard, "Generic Synopsis of the *Proctotrupidæ*." *Trans. Am. Ent. Soc.*, 13, p. 169, 1886.
W. H. Ashmead, *Mon. N. A. Proctotrypidæ*. Bul. 45, U. S. Nat. Mus., pp. 1–472, 1893. "Classification of *Proctotrypidæ*." *Jour. N. Y. Ent. Soc.*, 10, pp. 240–247, 1902; 11, pp. 28–35, 86–99, 1903.
C. T. Brues, "N. A. *Serphidæ*." *Jour. N. Y. Ent. Soc.*, 27, pp. 1–19, 1919. "*Serphoidea*." *Hym. Conn.*, Bul. 22, *Conn. Geol. & Nat. Hist. Surv.*, pp. 529–576, 1916.

[2] After C. T. Brues. *Hym. Conn.*, pp. 530–531, 1916.
J. H. Comstock, *Introd. to Ent.*, pp. 907–908, 1923.

7. Fore wings with a distinct stigma 8
   Fore wings without a distinct stigma 10

8. A closed, usually very short marginal cell (second $R_1 + R_2$) present. Antennæ with thirteen segments. Abdomen with a short cylindrical petiole, the second segment much longer and larger than the others .... **Proctotrupidæ**
   No closed marginal cell (second $R_1 + R_2$), but the basal part of the marginal vein (r) often present in the fore wings 9

9. Antennæ in female with ten or eleven segments, in the male with eleven segments **Ceraphronidæ** p 853
   Antennæ with twelve or more segments (few *Diapriinæ*) .... **Belytidæ** p. 853

10. Hind wings with a closed median cell (M); fore wings almost invariably with a closed marginal cell (second $R_1 + R_2$); antennæ with fourteen or fifteen segments (*Belytinæ*) .... **Belytidæ** p. 853
    Hind wings without any closed cells; fore wings without a closed marginal cell (second $R_1 + R_2$) 11

11. Abdomen margined laterally, the margin acute, but not sharply carinate; antennæ arising near the clypeus and with ten to twelve segments; scutellum not divided into three lobes *Telenominæ*) .... **Scelionidæ**
    Abdomen with sides rounded; scutellum divided by two oblique curved lines into three lobes (*Calliceratinæ*) .... **Ceraphronidæ** p. 853

PLATYGASTERIDÆ.[1] Platygasterid Parasites.

Amitus aleurodinis Haldeman. Length 0.75–1.00 mm., antennæ of both sexes 10-jointed, club of female 3-jointed, shining black, antennæ yellow and brownish, legs brown, yellow, and reddish. Reared from *Aleuroplatus coronatus* (Quaint.) at Berkeley, California. It occurs throughout the country. The aphelinid, *Eretmocerus haldemani* Howard, is thought to be parasitic on it in California.

Platygaster lampronota Fouts. Length 1.09–1.28 mm., body wholly dull red, the tarsi pale. Reared from terminal galls of *Rhopalomyia* sp. on chapparal broom in the San Francisco Bay region, California. *Platygaster californica* (Ashmead) (*Polygnotus*). Length 1.3–1.5 mm. black, antennæ and legs brown, the fore tibiæ and all tarsi yellowish. Probably reared from the galls like the preceding species and occurs in the same locality.

Platygaster heimalis Forbes. Length 1.4 mm., black, antennæ and legs partly brownish. An important parasite of *Phytophaga destructor* (Say) in the east, and ranges west into Oregon.

Platygaster leguminicolæ Fouts. Length 1.5 mm., shining black, legs partly reddish and yellow, wings infuscated. Parasitic on the clover seed midge, *Dasyneura leguminicola* Lint., in Oregon. Many other species have been reared in the west from undetermined *Cecidomyiidæ* inhabiting galls in various plants and in cones and the bases of the needles of coniferous trees.

SCELIONIDÆ. Egg Parasites.

Telenomus californicus Ashmead. Length 0.8 mm., eyes pubescent, antennæ 11-jointed black, portions of the legs pale yellow. Parasitic on eggs of *Hemerocampa vetusta* (Bdv.) in California.

Telenomus clisiocampæ Riley. Length 0.6 mm. Reared from *Malacosoma american* (Fabr.) in the middle west and from *Hemerocampa vetusta* (Bdv.) in California.

Telenomus coloradensis Crawford. Length 1 mm. Reared from eggs of *Hemerocampa oslari* (Barnes) in Colorado.

Telenomus gnophælæ Ashmead. Length 0.8 mm. Parasitic on the eggs of *Gnophæla latipennis* (Bdv.) in northern California.

Telenomus graptæ Howard. Length 0.6–1 mm. Parasitic on the eggs of *Aglais antiopa* (Linn.), *Telea polyphemus* (Cramer), and other *Lepidoptera* throughout the east, but is not yet recorded in the west.

Telenomus orygiæ Fitch. Length 0.8 mm. Parasitic on the eggs of *Hemerocampa leucostigma* (A. & S.), in the east and on the eggs of *H. vetusta* (Bdv.) in California.

[1] R. M. Fouts, "Rev. of N. A. Wasps of the Subfamily *Platygasterinæ*." *Proc. U. S. Nat. Mus.*, 63, art. 15a, pp. 1–145, 1924.

Telenomus utahensis Ashmead. Length 0.8 mm. First taken in Utah. Reared from eggs of a pentatomid bug (*Euschistus conspersus* Uhler?), at Berkeley, California, by the writer and determined by A. B. Gahan.

Trissolcus euschisti Ashmead. Length 1.5 mm., shining black, antennæ dark brown and yellow, legs black and yellow. Parasitic on eggs of *Euschistus servus* (Say) in the east; from *Brochymena tenebrosa* Walker in New Mexico; and reared by the writer from eggs of *B. sulcata* Van Duzee, at San José and Berkeley, California. Other following species are common in the east and all or some undoubtedly occur on the same hosts in the west: *Trissolcus murgantiæ* Ashmead on the eggs of *Murgantia histrionica* (Hahn); *Trissolcus podisi* Ashmead on the eggs of *Podisus maculiventris* (Say); and *Trissolcus thyantæ* Ashmead on the eggs of *Thyanta custator* (Fabr.); *Hadronotus anasæ* Ashmead and *H. carinatifrons* Ashmead on the eggs of *Anasa tristis* (De Geer); and *Hadronotus mesillæ* Ckll. on the eggs of a pentatomid bug in New Mexico.

Sparaison pilosum Ashmead. Length 4–5 mm., antennæ 12-jointed, shining black, tibiæ and tarsi yellow, hind tibiæ dusky at middle. Parasitic on the eggs of *Peranabrus scabricollis* (Thos.) in Montana, Idaho, and Washington, and also recorded in Nevada.

Scelio calopteni Riley. Length 3–3.4 mm., black, portions of the antennæ and legs yellow. Parasitic on the eggs of *Melanoplus atlanis* (Riley) in the east. *Scelio ovivorus* Riley is a similar species parasitic on the eggs of *Dissosteira carolina* (Linn.) in the east.

CERAPHRONIDÆ.

Dendrocerus conwentziæ Gahan var. *rufus* Gahan.[1] Length 2 mm., reddish brown suffused with dark brown. Parasitic on *Conwentzia hageni* Banks in Washington, Oregon, and California. This species was recently reared from this host at Santa Paula, California, by C. T. Dodds and determined by P. H. Timberlake.

BELYTIDÆ.

Isobrachium montanum Ashmead. Length 4–5 mm., eyes and ocelli absent, antennæ 13-jointed, head and thorax black, remainder bright or brownish yellow. Taken from nests of *Formica rufibarbis* Fabr. var. *occidua* Wheeler in Montana and also collected in Arizona.

Isobrachium myrmecophilum Ashmead. Length 3–3.5 mm., brownish black. Recorded in the east, and in Arizona, Montana, and California in the west. Taken from nests of *Tapinoma sessile* (Say) in California by W. M. Mann.[2]

FORMICOIDEA[3] (Superfamily)

Ants

FORMICIDÆ. Ants.

"The ants are social Hymenopterous insects, and may be distinguished from the social bees and wasps by having workers, or neuters, as they are less appropriately called, without wings. They are, moreover, readily

[1] A. B. Gahan, *Proc. Ent. Soc. Wash.*, 21, p. 123, 1919. Orig. desc.

[2] *Psyche*, 18, p. 29, 1911.

[3] A. Forel, *Formicidæ*. *Biol. Centr. Am. Hym.*, 3, pp. 1–169, 1899–1900.

W. M. Wheeler, *Ants*. Columbia Univ. Press, 1910. Complete Bibliography. "*Formicoidea.*" *Hymenoptera of Conn. Conn. Geol. and Nat. Hist. Survey, Bul.* 22, pp. 577–601, 1916.

H. Andrews, "California Ants." *Ent. News*, 27, p. 421, 1916.

W. M. Mann, "Guests of Cal. Ants." *Psyche*, 18, p. 27, 1911. "Northwestern Ants and Guests." *Psyche*, 18, p. 102, 1911.

For references to literature of P. A. Latreille, F. Smith, G. Mayr, S. B. Buckley, C. Emery, H. Forel, H. Edwards, Sir John Lubbock, H. McCook, E. Wasmann and others on Ants, see Complete Bibliography in Wheeler's *Ants* referred to above, pp. 578–648, 1910.

C. Emery, "*Formicidæ.*" *Gen. Insectorum, Fasc.*, 174A, pp. 1–94, 1921; Fasc. 174B, pp. 55–206, 1922; Fasc. 174C, pp. 207–397, 1922.

The writer is greatly indebted to M. R. Smith for reading and correcting the manuscript of this superfamily.

distinguished from these and all other Hymenopterous insects by the following characters:

"1. The first antennal joint in the workers and females, and often also in the males, is greatly elongated and forms what is known as the scape. The remaining shorter joints, constituting the funiculus, or flagellum, are articulated at an angle with the scape and can be folded up against it.

"2. One or two of the segments of the base of the abdomen are much reduced in size to form a pedicel, and these segments are either nodiform or bear an erect or inclined scale. When only one of these segments is present, it is known as the petiole; when two are present, the first is the petiole, the second the post-petiole. The swollen portion of the abdomen behind the pedicel is known as the gaster, and has one more visible segment in the male than in the female (queen).

"3. The legs of ants are distinguished from those of many other *Hymenoptera* in having only one instead of two small joints (trochanters) between the hip (coxa) and femur.

"4. The venation of the wings of male and female ants is much simplified and differs considerably from that of other *Hymenoptera*. The female, or queen ant, unlike the queens of the social bees and wasps, loses her wings after fertilization.

"The colonies of all our northern ants nest either in the ground or in decaying wood. The nests, or formicaries, may be under stones or logs, and always consist of irregularly excavated, intercommunicating cavities, unlike the regular paper or waxen combs of other social *Hymenoptera*. Often the nests are surmounted by earthen craters or dome-shaped mounds, or hills. The latter are perforated with cavities which serve as incubators for the young, that is, for the minute eggs, the legless, grub-like larvæ, and the pupæ. The pupæ are either naked or enclosed in elliptical cocoons which are spun by the mature larvæ.

"Many species of ants harbor in their nests messmates or parasites belonging to various groups of insects. Some of these so-called myrmecophiles are fed and cared for by the ants, others prey upon the ants or their brood. Certain species of ants may themselves become parasitic on other ants. A few of these parasitic species have lost their worker caste completely, and are, therefore, represented only by male and female individuals like the non-social *Hymenoptera*.

"The food of ants consists primarily of other insects found dead or in a moribund or helpless condition on the ground or vegetation. Many species, however, feed on honeydew, and either collect this sweet liquid directly from the plant lice and scale insects of which it is the excrement, or lap it up from the surfaces of the leaves on which it has fallen. Ants are, on the whole, beneficial insects, since they consume enormous numbers of dead and decomposing organisms. Many of the less abundant species are neither beneficial nor noxious." (By W. M. Wheeler in *Hymenoptera of Connecticut*, pp. 577–578.)

Some species, however, are responsible for a great deal of annoyance and loss to mankind. Besides the meddlesomeness and damage of the small house-infesting ants, many ants take it upon themselves to thoroughly disseminate plant lice, scale insects and other similar honeydew-producing

plant pests in the gardens, fields, and orchards, and then zealously guard off the parasites and other natural enemies in order to secure the honey-dew for food. Other species feed on seeds and small particles of plants, and a few directly attack the roots and bark of succulent plants and fruit trees. The life histories and social habits of ants are entirely too complicated to attempt a review here, and the reader is referred particularly to the works of Forel, Lubbock, McCook, Wheeler, Wasmann, and others for this information. Briefly and partially summarized, an ant colony consists of the following:

Ant Colony—*May possess one or several nests.*
- *Founder—Mother or queen, alone or with aid of workers.*
  - Often several or many queens (in a well established colony).
- Descendants—Wingless females or workers.
  - True workers, small and very large forms.
  - Soldiers.
  - Young winged males.
  - *Young winged females.*
  - Young fertilized and deälated queens.
- Other Members of Colony.
  - Ants
    - Slave ants.
    - Socially parasitic ants.
  - Symphiles
    - *True guests—protected for exudations as aphis, coccids,* beetles, crickets, etc.
    - Tolerated tenants.
    - Persecuted tenants.
    - Parasites.
    - *Food producers.*

The artificial control of ants is not an altogether satisfactory accomplishment, and all known methods appear to fail at times. For those species living in well defined nests almost complete extinction is had by pouring into the openings quantities of volatile liquids after the ants are all in, and closing up the doorways. This can best be done when the ground is damp, but can also be accomplished in dry soil if sufficient material is used. For this purpose gasoline, carbon disulfid, or a solution made by dissolving one ounce of cyanide in one gallon of water, can be effectively used. Sodium cyanide dust and sodium fluorid are also effective if placed in the runways and paths. W. T. Clarke found that a mixture composed of sodium fluoride 6 parts, starch 2 parts, and finely ground pyrethrum 2 parts, was very good in beds, cupboards, or on the floors of steamships and houses, because it does not irritate the skin of humans and is very effective in killing the small pestiferous ants. There are many kinds of poisons for those species which are fond of sweets; the strong poisons for the ordinary ants and the weak solutions for the Argentine ant.

Ant Syrup for Native Ants.

White arsenic	2 oz.
Concentrated lye	1 oz.
Sugar	1 lb.
Water	1 pt.

Government Argentine Ant Syrup.

Granulated sugar	12 lbs.
Water	11 pts.
Tartaric acid (crystalized)	7 gm.
Benzoate of soda	9 gm.
Boil slowly for 30 minutes. Allow to cool.	
Dissolve sodium arsenite (C. P.)	¾ oz.
In hot water	½ pt.
Cool. Add poison solution to syrup and stir well.	
Add to the poisoned syrup:	
Honey, strained	2 pounds
Mix thoroughly.	

These liquid poisons are put in covered tin or earthenware containers with a sponge at the bottom and holes near the top to admit the ants. The containers should be placed in the runways of ants and kept filled so that at least the top of the sponge is exposed. Flavored and poisoned gelatine mixtures are also used for this purpose. Beehives, nests, and similar objects are made ant-proof by placing the legs in cans of water containing a film of oil or crude oil alone, or by troughs containing the same materials about the bases, or by using bands of string or rope treated in a saturated solution of corrosive sublimate.

KEY TO SUBFAMILIES [1]

(Workers)

1. Cloacal orifice ventral, slit-shaped; sting well developed or vestigial; abdominal pedicel consisting of one or two segments 2
   Cloacal orifice terminal, circular, surrounded by a fringe of hairs; abdominal pedicel consisting of only a single segment; no constriction between the first and second gastric segments; pupæ usually enclosed in cocoon ..... **Formicinæ** p. 866

2. Sting developed, sometimes very small but nevertheless exsertile; abdominal pedicel consisting of one or two segments; when of only one, a distinct constriction between first and second gastric segments 3
   Sting vestigial; abdominal pedicel consisting of a single segment; no constriction between first and second gastric segments; anal glands which produce a secretion with a peculiar rancid-butter odor ("Tapinoma odor") often present; pupæ naked .... **Dolichoderinæ** p. 863

3. Pupæ always enclosed in cocoons; abdominal pedicel consisting of a single segment; gaster with a distinct constriction between its first and second segments; frontal carinæ separated or close together; when close together, dilated to form oblique or horizontal laminæ partly covering insertions of antennæ .... **Ponerinæ** p. 869
   Pupæ naked; abdominal pedicel consisting of two segments 4

4. Frontal carinæ very close together, almost vertical, not at all covering antennal insertions; eyes always very small or absent; tropical and subtropical .... **Dorylinæ** p. 868
   Frontal carinæ of a different conformation and covering the antennal insertions; eyes rarely vestigial or absent; cosmopolitan .... **Myrmicinæ** p. 857

Ants are particularly abundant in the more arid southwest but they are by no means rare throughout our entire region. It is possible here to give only the commoner forms.

[1] After W. M. Wheeler, *Hym. Conn.*, pp. 579–580.
W. M. Wheeler, "The Subfamilies of *Formicidæ*." *Psyche*, 20, pp. 46–55, 1920.

MYRMICINÆ (Subfamily). Myrmicine Ants. **The minute black ant,** *Monomorium*[1] *minimum* Buckley (Fig. 721), is a very minute slender black species which constructs nests with small craters in the soil or rotten wood.

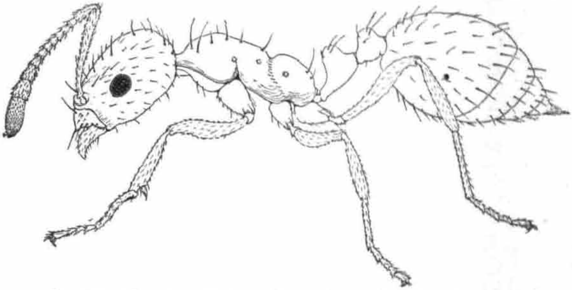

Fig. 721.—The minute black ant, *Monomorium minimum* Buckley. Worker. (After Woodworth.)

It may invade houses. The range is general throughout the country. It is quite common in the San Francisco Bay region, California, and is recorded also from New Mexico. The larvæ of *Microdon* sp. occur in the nests in the former area. *M. ergatogyna* Wheeler is even smaller and occurs in Tulare and Alameda counties, California. **The little red ant or Pharaoh's**

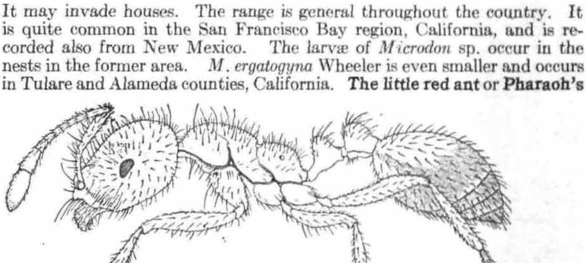

Fig. 722.—The fire ant, *Solenopsis geminata* (Fabr.). Worker. (After Woodworth.)

ant, *M. pharaonis* (Linn.), is a very small red ant which in California normally nests in the soil out of doors, but which commonly invades houses, where it nests and appears more troublesome in the east than in the west.

[1] C. L. Marlatt. "House Ants, Kinds and Control." *Farmers' Bul.*, 740, U. S. Dept. Agr. 1916.

It is a cosmopolitan species and is most common in the warmer Southwestern States of our region. *M. destructor* (Jerdon) is a pale or very dark brown species which is very abundant and troublesome in the American tropics and which accompanies the steamships from those regions into the harbors of the Pacific States. It does not yet appear however to be established in any of the Western States.

The fire ant, *Solenopsis geminata* (Fabr.) (Figs. 722, 723), although a small ant, is much larger than any of the preceding species. The length varies from 1 mm. in the very small workers to 6 mm. in some of the winged forms. The color of the workers is pale yellowish or reddish with blackish abdomen, that of the winged forms the same or entirely shining black or entirely reddish. They travel in columns and construct small nests with small craters which are confused or in series and which are located in hard ground beside rocks or cow chips or along paths, roads, or in door yards. They are pugnacious and are capable of stinging severely. The species is tropical and subtropical and ranges from the American tropics northward through Mexico into the Southern and Southwestern States, and into British Columbia along the Pacific. The food consists of insects, seeds, and various forms of living plants. Considerable damage to crops occurs in sections. In Java the ants carry away the seeds of tobacco from the seed-beds and are a pest of consequence; in Porto Rico they nest at the bases of the citrus trees and feed on the tender twigs causing them to die; in Arizona they eat the tender shoots of nursery and young orchard trees; in California the writer has observed them nesting in strawberry patches and eating the ripening berries, nesting about the bases of young grapefruit trees in Imperial County and partially or entirely barking young trees, eating the edges of the leaves of mature lemon trees, devouring the planted seed potatoes and girdling young potato plants in the soil, and young cabbage and sorghum plants. They have also been observed girdling plants of the edible passion vine in California. In most of the above California records the subspecies *maniosa* Wheeler was responsible for the damage. The mealybug, *Phenacoccus solenopsis* Tinsley, has been taken in the nests in New Mexico. The phorid flies, *Pseudacteon crawfordi* Coq., in Texas and *P. curriei* Malloch, in British Columbia, are parasitic in the heads of this ant. The liberal use of soil fumigants as given at the beginning of this chapter is most efficacious in control.

FIG. 723.—Portion of a young grapefruit tree showing the bark partially removed by workers of the fire ant, *Solenopsis geminata* (Fabr.).

The thief ant, *Solenopsis molesta* (Say), is known as the kafir ant in Kansas[1] and destroys kafir and Indian

[1] J. W. McColloch and W. P. Hayes, *Jour. Econ. Ent.*, 9, p. 30, 1916.

corn as well as the larvæ of insects. The species occurs independently or in the nests of other ants. The variety *castanea* Wheeler occurs in Colorado and New Mexico, and the variety *validiuscula* Emery is common from California into Washington. The tropical American species, *S. hamatum* (Fabr.), is recorded in Southern California.[1]

The small harvester ant, *Pheidole californica* Mayr, is a very small dusky yellow or reddish species 0.5 to 1 mm. long which commonly nests under stones, sticks, and so forth, and is frequently in company with the thief ant in California. It stores small seeds of grasses and other plants. *P. desertorum* Wheeler occurs in Texas and Arizona. *P. grallipes* Wheeler (*P. longipes* Pergande) ranges from Mexico into California. *P. hyatti* Emery is typically a yellow species which commonly nests under stones and at the bases of shrubs in dry fields of Southern California, and ranges east into Texas and Mexico. The histerid guest, *Terapus infernalis* (Fall), occurs in the nests. *Pheidole oregonica* Emery occurs in Oregon and Washington.

The acrobat ant, *Cremastogaster lineolata* (Say) (Fig. 724), is a common small sluggish ant with short, wide, sharply pointed abdomen which is

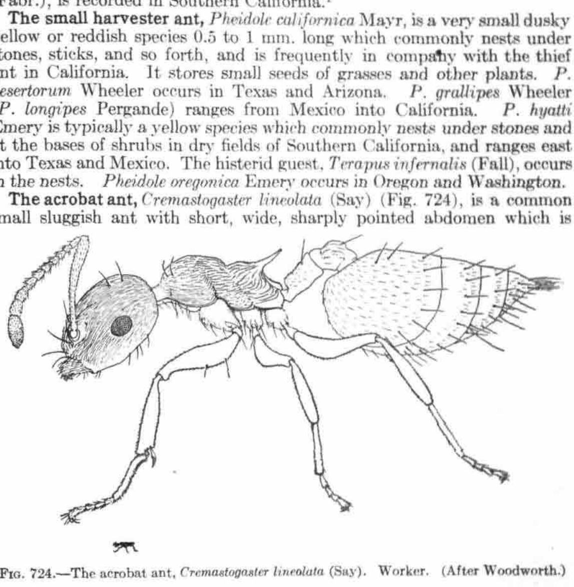

FIG. 724.—The acrobat ant, *Cremastogaster lineolata* (Say). Worker. (After Woodworth.)

often held over the rest of the body. The workers attend aphis and other honeydew-producing insects which are often sheltered with mud cartons or tents. They usually nest under stones but often completely honeycomb dry logs and stumps with their galleries. The subspecies *leviuscula* Mayr var. *clara* Mayr is reddish with black abdomen and ranges from Texas into Southern California, and the var. *californica* Emery of the same subspecies, also occurs in California. The subspecies *coarctata* Mayr is common under dry stones in moist places in California, and is accompanied by the guest, *Myrmecophila oregonensis* Bruner. The variety *mormonum* Emery occurs in Utah and New Mexico. The subspecies *opaca* Mayr var. *punctulata* Emery inhabits Texas, New Mexico, and Colorado, and the var. *debilis* Wheeler has the same ranges and extends into Mexico. **The short-**

[1] *P. C. Jour. Ent. and Zoöl.*, 10, p. 24, 1918.

spined acrobatic ant, *Cremastogaster brevispinosa* Mayr, ranges from South America through Mexico into Arizona and *C. atra* Mayr occurs in Mexico and Arizona. They both commonly attend scale insects in the arid regions.

The black harvester ant, *Messor andrei* (Mayr) (Fig. 725), is a medium-sized black ant with brownish thorax and peduncle, and averages 5–6 mm. in length. It lives in large colonies, the nests having flattened craters with a single or with several openings. In the late afternoons long files of workers are actively engaged in collecting seeds which are husked and stored in the granaries, the husks being discarded around the outskirts of the crater. This is an arid species occurring in the southern parts of California and ranging north beyond the San Francisco Bay region. The ant cricket, *Myrmecophila oregonensis* Bruner, and the scarabæid beetles, *Cremastocheilus armatus* Walker and *C. schaumi* Lec., occur in the nests. *Messor pergandei* Er. André is a shining black species of about the same size and has similar habits. It occurs in northern Mexico and in Arizona and Southern California, having been taken as far north as Fresno, California.

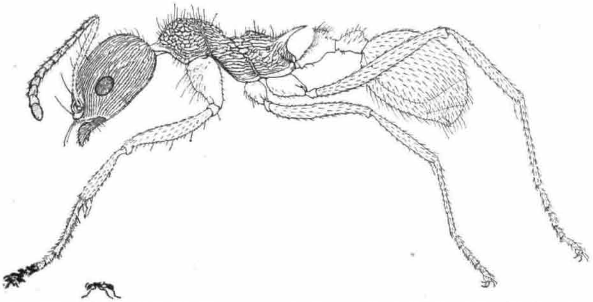

FIG. 725.—Worker of the black harvester ant, *Messor andrei* (Mayr). (After Woodworth).

Aphænogaster subterranea (Latr.) subsp. *occidentalis* Emery ranges throughout the west from Colorado to the Pacific and into Washington.

The Texan harvester or agricultural ant, *Pogonomyrmex barbatus* (F. Smith), is the largest and most powerful harvester. The typical form is 7–9 mm. long and has the head, thorax, and legs black, the petiole and abdomen red. It lives in large colonies and the nests consist in a large opening 2 to 4 inches in diameter at the level of the soil surface or a small conical crater of pebbles, surrounded by a bare circle 2 to 12 feet in diameter. These bare spots occur in native vegetation or in alfalfa fields or other cultivated areas. The ants forage all day and often have definite paths leading into the surrounding areas. They bite and sting severely. The subspecies *rugosus* Emery has the petiole coarsely rugose and is common in Texas, New Mexico, Arizona, and Southern California. The var. *fuscatus* Emery has the head and thorax brownish red and the abdomen partly or entirely brown. It ranges in Texas, New Mexico, and Colorado.

The var. *marfensis* Wheeler has the head, thorax, and legs black, the petiole brown, and the abdomen red. It occurs in Texas and New Mexico.

The California harvester ant, *Pogonomyrmex californicus* (Buckley) (Fig. 726), is one of the commonest species in Texas, New Mexico, Arizona, California, and Nevada. The workers are pale ferruginous red and average 5–6 mm. in length; the queens are the same color and 8 mm. long; the males are 7.5 mm. long and black and red. The queens appear in May and excavate small nests forming a fan-shaped crater at one side of the opening. The colonies become quite large. The nests are always in sand or fine gravel with small or large craters, but without cleared areas and definite paths. There is usually but one entrance, although occasionally more, which are closed at night. The ants are great foragers and collect seeds all day long, excepting about noon when they remain in the nests. When active they frequently carry the abdomen erect. They are ferocious when

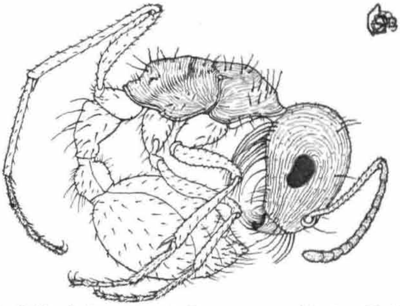

FIG. 726.—The California harvester ant, *Pogonomyrmex californicus* (Buckley). Worker coiled in natural attitude when picked up. (After Woodworth.)

disturbed and fearlessly bite and sting intruders. The subsp. *estebanius* Pergande is black and reddish in the worker caste and occurs in Lower California and Southern California; the subsp. *longinodis* Emery is pale red and brown and occurs in the desert in California; and the subsp. *maricopa* Wheeler is ferruginous red and inhabits Mexico, Texas, New Mexico, Arizona, and California.

The desert agricultural ant, *Pogonomyrmex desertorum* Wheeler,[1] is a small yellowish red ant 5.5–6.5 mm. long, which resembles *P. californicus* Buckley, but differs from this species "in possessing epinotal spines and smooth posterior corners to the head and from this and all other described North American species, in the very dense and delicate cephalic rugæ." It inhabits dry stony areas above the high water marks of streams and lives in solitary nests with a single central opening and small craters 4 to 6 inches in diameter, in northern Mexico, Texas, New Mexico, and Arizona. It feeds on grass seeds.

[1] W. M. Wheeler, *Psyche*, 9, p. 387, 1902. Orig. desc.

The western harvester or mound-building prairie ant, *Pogonomyrmex occidentalis* (Cresson),[1] is a large reddish ant 10 mm. long with a distinct tooth on the ventral surface of the petiole and the head opaque with distinct interrugal punctures. It lives in large colonies, clears away large areas 6 to 15 feet in diameter, and constructs conspicuous mounds 4–12 inches high and 2 to 3 feet in diameter, which are covered with pebbles and have the single, or, rarely, several openings at the base of the southern or eastern slope. The galleries honeycomb the soil beneath to a depth of 9 feet. The ants swarm in damp weather during August and are very pugnacious when disturbed. The species frequently occurs at 6,000 feet or higher in Kansas, Colorado, Wyoming, Idaho, New Mexico, Arizona, and Nevada. The var. *subnitidus* Emery inhabits California. *P. subdentatus* Mayr lives in small colonies and ranges in Arizona and Southern California.

Myrmica mutica Emery is ferruginous red in the worker caste, the individuals of which are 4–6 mm. in length. This species is common in the mountain valleys and nests in the loose silty soil in the flood plains, often in alkali places, but does not like gravelly or stony soil. It is known in New Mexico, Colorado, Utah, Washington, and British Columbia. The histerid beetle guest, *Dendrophilus californicus* (Horn), has been taken in nests in Washington and the symbiotic ant, *Symmyrmica chamberlini* Wheeler, occurs in nests in Utah. *Myrmica aldrichi* Wheeler is brownish yellow, 5–6 mm. long and occurs in Idaho. *M. bradleyi* Wheeler is 4–7 mm. long, shining black and yellow in the worker caste, and occurs in the high Sierras of middle California. *M. hunteri* Wheeler is brownish red and black with a black band across the posterior portion of the first gastric segment, and occurs in the mountains of Montana. Various forms of *Myrmica* occur in the west as follows: *M. brevinodis* Emery in Colorado; var. *decedens* Wheeler in Colorado; var. *frigida* Forel in British Columbia; var. *subalpina* Wheeler in Colorado; and var. *whymperi* Forel in British Columiba. *Leptothorax emersoni* Wheeler subsp. *glacialis* Wheeler lives in the nests of the var. *subalpina* Wheeler in Colorado. *Myrmica scabrinodis* Nyl. subsp. *lobifrons* Pergande var. *glacialis* Forel occurs in Alaska and in British Columbia.

The Arizona fungus ant, *Atta* (*Trachymyrmex*) *arizonensis* Wheeler, is spiny, ferruginous red, and 3.5–5 mm. long. It feeds on ambrosia fungi which are grown in the galleries below ground and the nests can be located by the turret-shaped craters and the bits of bright yellow fungus discarded about the entrance. It lives in very large colonies in the arid mountain canyons of northern Mexico and Arizona. **The desert fungus ant,** *Atta* (*Trachymyrmex*) *desertorum* Wheeler, is similarly colored, but smaller, measuring 2.5–3.5 mm. in length. It nests in the dry arroyos of Arizona.

The leaf cutting ant, *Atta* (*Moellerius*) *versicolor* Pergande, is often associated with the preceding species. The polymorphic workers of the smallest caste are similar in color and size to the former. They harvest bits of leaves and other parts of plants on which to grow the fungus in the nest-gardens. *Cyphomyrmex rimosus* Spinola var. *comalensis* Wheeler (Fig. 727) is a very small soil-colored ant which grows a fungus in the excrement of caterpillars in nests under rocks and logs in the damp shade of trees and shrubs along the banks of dry and flowing streams and irrigation ditches in Southern California, Arizona, and east into Texas.

The pavement ant, *Tetramorium cæspitum* (Linn.), gets its common name from the habit of nesting under pavements in the Eastern States; it nests, however, in sandy or rocky places as well. It is a small dark European and Asiatic species which has been introduced into many parts of the Atlantic sea-

[1] H. B. Hungerford and F. X. Williams, *Ent. News*, 23, p. 242, 1912.

board, and is now fairly common in Central California along the Sacramento and San Joaquin rivers. The ants frequently attack the tubers and stalks of potatoes, and roots and stalks of beets, cabbage, carrots, and many other plants which are greatly injured or often completely killed. They also

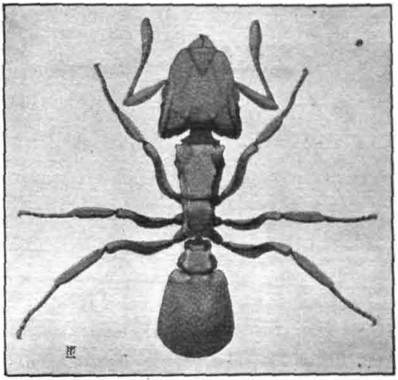

FIG. 727.—The fungus ant, *Cyphomyrmex rimosus* Spinola var. *comalensis* Wheeler. Worker. (After Woodworth.)

commonly attend plant lice, scale insects, leafhoppers, and other homopterous insects, and occasionally store grass seeds and devour dead animal matter.

DOLICHODERINÆ (Subfamily). **The earth-colored ant,** *Dorymyrmex pyramicus* (Roger), is a small species 1.5–2 mm. long with reddish head and thorax and black abdomen. The ants commonly blend with the earth where they live and are not at all conspicuous. They live in nests with small craters 8–10 cm. in diameter, along roadsides and in towns, or often on or near the craters of large species. They feed partially on the refuse and other material collected by the large workers, and are a household pest of some importance in Southern California. This southern species has been taken in New Mexico and California, the writer having specimens from Los Angeles, Fresno, and Berkeley in the latter State. The var. *niger* Pergande is an entirely dark form also taken in Fresno, California, and the var. *bicolor* Wheeler is a larger red and black form taken in Arizona and at Whittier, Dinuba, and Fresno, California.

The odorous ant, *Tapinoma sessile* (Say) (Fig. 728), is a small black ant with reddish brown legs and normally about 2 mm. long, although some workers are considerably larger and others very minute. They are most easily distinguished by the fact that the anterior portion of the gaster overhangs the petiole. The ants nest under stones and in trees, stumps,

logs, birds' nests, and so forth. They are very common in New Mexico, Colorado, Arizona, California, Oregon, Washington, and British Columbia. This ant is often the most troublesome house-infesting species in towns and cities, where it has not been driven out by the Argentine ant. It is easily controlled with the strongly poisoned ant syrups. The ant cricket, *Myrmecophila oregonensis* Bruner, occurs in the nests in California, Oregon,

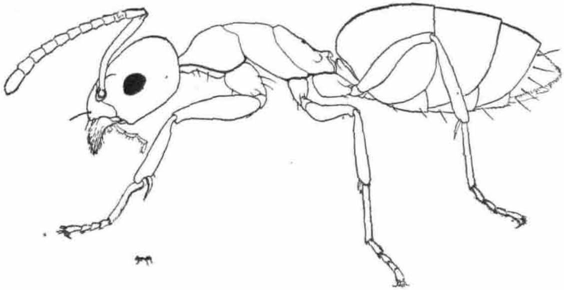

FIG. 728.—The odorous ant, *Tapinoma sessile* (Say). Worker. (After Woodworth.)

Washington, and British Columbia, and the proctotrupid, *Isobrachium myrmecophilum* Ashm., is thought to be parasitic on it in California.[1]

The Argentine ant, *Iridomyrmex humilis* Mayr [2] (Figs. 729–731), is a very destructive South American species native to Argentina Republica and Brazil, which was first discovered in New Orleans, Louisiana, in 1891 and subsequently appeared in large numbers in California in 1908. Since first noted, it has become a very serious garden and household pest throughout California as far north as the San Francisco Bay region. In the latter region it is most abundant and pestiferous during dry years, and notably decreases following wet cold winters. It is therefore a strictly subtropical and warm temperate species and cannot stand hard freezing winters. The workers are small, dark brown ants 1–2 mm. long, with slender bodies and noticeably long antennæ, and without odor when crushed; the queens are brown with darker abdomen and silky pubescence, 6 mm. long, and are found with wings or with only wing pads; the males are shining brownish black, 5–6 mm. long, and winged; the eggs are elliptical, pearly white, smooth, and very small. This ant nests in large colonies under stones, pavements, walks, logs, refuse, or other objects, or in the cracks of the soil, and spreads out over large areas composed of innumerable nests. There is but one caste of long lived workers which are untiring foragers, invading

[1] W. M. Mann, *Psyche*, 18, p. 29, 1911.

[2] C. W. Woodworth, *The Control of the Argentine Ant*. Bul. 207, Cal. Agr. Exp. Sta. 1910.

W. Newell and T. C. Barber, Bul. 122, Bur. Ent. U. S. Dept. Agr. 1913.

E. O. Essig, *Inj. and Ben. Ins. Cal.*, 2d ed., p. 379, 1915.

E. R. Barber, Bul. 377, *Prof. Paper*, Bur. Ent. U. S. Dept. Agr. 1916.

other ants' nests, houses, stores, hotels, and other buildings, the hives of honeybees, hens' nests, and so forth, in search of sweets or animal food. Like many ants, they are fond of sweets in the form of honeydew, honey,

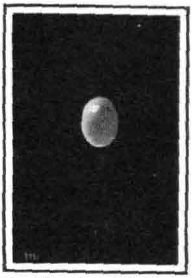

FIG. 729.—Egg of the Argentine ant, *Iridomyrmex humilis* Mayr. (After Woodworth.)

FIG. 730.—Mature larva of the Argentine ant, *Iridomyrmex humilis* Mayr. (After Woodworth.)

syrups, and so forth, and also greedily devour dead insects, reptiles, rodents, or cooked meats of all kinds, and, rarely, carry off small seeds. They also attend and distribute throughout the gardens, plant lice, scale insects, and other honeydew-producing insects, and then carefully guard off the

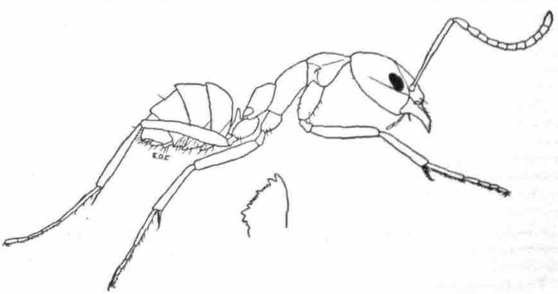

FIG. 731.—Worker of the Argentine ant, *Iridomyrmex humilis* Mayr, and mandible showing arrangement of teeth.

natural enemies. Root-infesting aphis and mealybugs are favorite guests and their control is most difficult where this ant abounds. In the late summer and fall definite wide trails are formed over which pass countless numbers of workers busily engaged in food collection and extending the bound-

aries of the colonies. There is little activity during the winter. The eggs hatch in from 18 to 55 days; the larvæ mature in about 31 days; and the pupæ develop in 15 days. The whole life cycle occupies about 78 days. Egg-laying begins in the spring and continues until winter. The sexes appear in the spring. The control consists in the use of weakly poisoned syrups listed at the beginning of this chapter, which are placed in accessible containers throughout the gardens, yards, and buildings frequented by the ants. They tire of a certain sweet so it is advisable to occasionally change to honey or to fruit gelatins. Never tiring efforts are necessary to cope with this aggressive pest, but success is sure if one is willing to see that the ant cans are always filled and sufficiently abundant to feed all the ants. For immediate relief, strong poisons are often very effective, and are usually used in the gardens and buildings of the writer. A closely related, but apparently harmless, pale yellow species is *Iridomyrmex analis* Er. André, which occurs in Arizona, California, and occasionally in Washington.

FORMICINÆ (*Camponotinæ*) (Subfamily). Formicine or Typical Ants. **The honey ant,** *Prenolepis imparis* (Say), is a small shining black species with reddish brown legs or reddish brown throughout, the workers averaging 2–3 mm. in length. Winged forms are about the same color and size. The ants nest in damp, shady, clayey soils and the workers often have the abdomen so greatly distended with nectar or honeydew that they can scarcely walk. Swarming occurs in March in California, where this species is very common. The ant cricket, *Myrmecophila oregonensis* Bruner, occurs in the nests, which also harbor the thief ant, *Solenopsis molesta* (Say) var. *validiuscula* Emery.

The American black ant, *Lasius niger* (Linn.) subsp. *alienus* Förster var. *americanus* Emery, is 8.5 mm. long and lives in small nests in Idaho, Washington, and British Columbia. The ant cricket, *Myrmecophila oregonensis* Bruner, and the beetle, *Adranes taylori* Wickh., occur in the nests. The var. *neoniger* Emery is known in New Mexico, Colorado, and Washington, while the var. *sitkaenses* Pergande inhabits the higher mountainous regions of Colorado and extends northward into British Columbia and Alaska.

Ants belonging to the large genus *Formica* are of medium size, the workers with a well developed sting. The females are about the same size as the workers and usually winged or rarely apterous; the males are winged or wingless, usually with long gaster. They often make huge mounds of leaves and sticks about stones or small trees and shrubs for the incubation of the brood. The workers commonly attend plant lice for the honeydew and also the caterpillars of lycænid butterflies. Many species are held as slaves by other species, as well as by other genera such as *Polyergus*. Of the many species, subspecies, and varieties, the few most common western forms are here listed.

The fuscous ant, *Formica fusca* Linn., is one often met in fields and forests of the lowlands, hills, and mountains. The var. *densiventris* Viereck occurs in New Mexico; the var. *gelida* Wheeler is reddish with the head and gaster dark brown, the workers averaging 3–5 mm. in length, and occurring in large numbers in the Lake Tahoe region of California and Nevada; the var. *argentata* Wheeler is common on damp hillsides in Colorado, Arizona, California, and Washington; the var. *neoclara* Emery is pale reddish

throughout, 4–5 mm. long, and occurs in Colorado, New Mexico, and at Visalia, California; the var. *subsericea* Say is a black species which commonly attends plant lice in California, the var. *neorufibarbis* Emery occurs in California, Oregon, Washington, British Columbia, and Alaska. The var. *subænescens* Emery is brownish black, the workers 3–6 mm. long, and the alate queen 10 mm. It is common in the low coastal plains and in the high interior mountains of California, and also occurs in Nevada, Colorado, and northward into British Columbia and Alaska. The ant cricket, *Myrmecophila oregonensis* Bruner, occurs in the nests of *neorufibarbis* Emery; the scarabæid beetle, *Cremastocheilus kochi* Lec., in the nests of *subænescens* Emery; and the dermestid beetle, *Hetærius tristriatus* Horn, in the nests of *argentea* Wheeler.

The red ants are very abundant throughout our region. The commonest form is *Formica rufa* Linn. subsp. *obscuripes* Forel, the workers of which are ferruginous red with the abdomen and often portions of the legs black or brown. It is a pugnacious species which readily attacks intruders disturbing the aphis guests or the large nesting mounds which are often built of small sticks, leaves, and pine needles about small trees and shrubs in the high mountains of California, Nevada, Utah, Colorado, Oregon, Washington, Idaho, British Columbia, and other Western States. It is recorded by R. C. Treherne [1] as destroying the pistils in order to reach the nectar in the blossoms of apple, cherry, peach, and pear trees, and causing considerable losses to fruit growers in British Columbia. The scarabæid beetle, *Aphodius suspectus* Mann., and the larvæ of the syrphid fly, *Microdon tristis* Loew var. *cothurnatus* Bigot, occur in the nests.

The sanguinary ant, *Formica sanguinea* Latr. subsp. *subnuda* Emery, is similar in size and appearance to the preceding species, but the abdomen is paler. It is an alpine species and enslaves varieties of *Formica fusca* Linn., or lives in slaveless colonies in California, Nevada, Idaho, and other Western States.

The western red ant, *Formica rufibarbis* Fabr. var. *occidua* Wheeler (var. *occidentalis* Wheeler), is reddish, often with dusky head and with dark abdomen, rather slender, the workers 4–6 mm. long. They commonly attend aphis in the wilds, orchards, and gardens of California, and occur throughout the west. *Myrmecophila manni* Sch. and *Hetærius californicus* Horn are guests.

Formica neogagates Emery var. *lasioides* Emery is of a uniform shining dark brown or is reddish brown excepting the dark gaster, and 3–4 mm. long. It occurs in New Mexico, California, Nevada, Oregon, and Washington. *Formica subpolita* Mayr is a very common species in the San Francisco Bay region of California and occurs throughout the west. The workers are 3–4 mm. long, shining brownish-red or chestnut brown, with the thorax, petiole, and legs reddish. They nest under stones in bare or grassy places and attend aphis, mealybugs, and so forth. The pseudoscorpion, *Chelanops dorsalis* Banks, often occurs with the ants on the undersides of the rocks in California, and the parasite, *Elasmosoma vigilans* Ckll. attacks the species in Colorado.

The western amazon ant, *Polyergus rufescens* (Latr.) subsp. *breviceps* Emery, is a beautiful red species 4–6 mm. long, which ranges from New Mexico and Colorado into California, and is common at altitudes of from 2,000 to 2,500 feet. It lives in large colonies and is noted for its slave-mak-

[1] *Can. Ent.*, 47, p. 104, 1915.

ing habits, making forays to nests of other ants, chiefly those of *Formica fusca* Linn. varieties *argentata* Wheeler and *subsericea* Say, and *Formica cinerea* Mayr var. *neocinerea* Wheeler, and carrying off the eggs, larvæ, and pupæ, the adults of which subsequently become slaves in the colonies of the raiders. The variety *læviceps* Wheeler is shining reddish brown, 5–7 mm. long, and occurs in the San Francisco Bay region, California, in the Lake Tahoe region, California, and in Nevada. *Polyergus lucidus* Mayr subsp. *montivagus* Wheeler is an orange-yellow species taken on Mt. Tamalpais, California.

The carpenter ants belonging to the genus *Camponotus* live in large colonies usually under stones or in dead trunks of standing trees, stumps, or logs, and often extend their extensive galleries far underground. The workers vary greatly in size and in some species are the largest of our ants. They attend aphis and other homopterous insects and the caterpillars of certain lycænid butterflies. **The giant carpenter ant,** *Camponotus levigatus* (F. Smith), is shining black throughout or sometimes with reddish brown legs. The workers vary from 6–10 mm.; the winged males average 10 mm., and the huge winged and deälated queens vary from 13–15 mm. in length. The workers and dealated queens are to be found throughout the summers wandering singly on the ground or on logs, trees, and stumps in the forests of the Rocky, Sierra Nevada, and Cascade Mountains. *C. herculeanus* (Linn.) is a similar appearing species which occurs throughout the world in the north temperate regions. The variety *whymperi* Forel is known in Colorado and British Columbia, and the variety *modoc* Wheeler occurs in California, Oregon, and Washington. The ant cricket, *Myrmecophila oregonensis* Bruner, is a guest in the nests.

The maculate carpenter ant, *Camponotus maculatus* (Fabr.) subsp. *vicinus* Mayr, is almost as large as the forms of the preceding ant, but is variably marked rich reddish brown and black. This species commonly nests under stones in the lowlands and high mountains from the Rocky Mountains to the Pacific Ocean. The ant cricket, *Myrmecophila oregonensis* Bruner, is a common guest. The variety *nitidiventris* Emery is black and shining reddish brown, and has a similar distribution. The variety *semitestaceus* Emery is black and dark brown and yellow. It occurs at higher elevations throughout the west. *Camponotus maccooki* (Forel) is dusky or pale yellowish brown or amber, with the head black and the abdomen dusky or partially or wholly black, and varies from 6–12 mm. in length. It is the commonest species of this genus in the San Francisco Bay region, California, and commonly nests under stones. This species is frequently troublesome in the houses in New Mexico and is also known to occur in Arizona and Colorado. The ant cricket, *Myrmecophila oregonensis* Bruner, is a guest.

DORYLINÆ (Subfamily). Legionary, Driving, or Visiting Ants. These are mostly large tropical ants which live in small or large colonies and are nomadic, often marching in large armies which may completely overrun extensive areas. The males are very large and winged and the females and workers are apterous and blind. The food consists chiefly of animal matter. They attack and overcome insects and other animals as large as rats, and houses are rendered uninhabitable by their presence. Some species range from tropical America into the Southern and South-

western States. These species, however, do not form large armies, but hunt in small files from large nests. They frequently raid the nests of other ants and carry off the young. *Eciton californicus* Mayr occurs in California, Arizona, and New Mexico. *E. arizonensis* Wheeler and *E. oslari* Wheeler occur also in Arizona; *E. schmitti* Emery ranges in Texas, New Mexico, and into Colorado; *E. harrisi* Haldeman and *E. melsheimeri* Haldeman, in Texas.

PONERINÆ (Subfamily). Ponerine Ants. This subfamily comprises a group of primitive ants widely distributed, common in Australia, with a fair representation in the Atlantic and Southern States, and a few species occurring in the southwest. The large or small colonies usually occur in the soil or in rotten wood. There is little difference in the size of the different castes; all are carnivorous; pupation occurs within a cocoon; the males and females are winged; and the workers are monomorphic.

Stigmatomma pallipes Haldeman subsp. *oregonense* Walker occurs in Oregon. A number of genera and species occur in Texas, one of which, *Ponera inexorata* Wheeler, ranges through New Mexico into Colorado.

CHRYSIDOIDEA (Superfamily)

CHRYSIDIDÆ (*Chrysidæ*).[1] Cuckoo Wasps, Gold Wasps, Ruby Wasps. This is a small family of little, winged, brilliant metallic green and blue wasps, normally with three abdominal segments visible from above. The adults visit rocks, walls, fences, and so on, and are often taken in sweepings. They possess a tubuliferous ovipositor and can roll into a ball for protection. They are known as cuckoo wasps from the habit in the females of laying their eggs in the provisioned cells particularly of the solitary mud wasps and other aculeate *Hymenoptera*, while some foreign species are parasitic on *Lepidoptera*. The fat legless larvæ are chiefly parasitic on the larvæ of the host, although in some instances they are thought to devour the provisions consisting of various insects. They hibernate as larvæ and pupate in a cocoon within the cell of the host in the spring, the adults emerging in a short time. They are of no economic importance. A few of the most widely distributed western forms are the following:

Ellampus læviventris (Cresson) (*Omalus*), 4.5–5.5 mm. long; blue and green with purplish reflection; California, Colorado, New England, and Canada.

Notozus marginatus Patton, 3.5–5 mm. long; varying from bright green with golden iridescence to blue with purple or black reflections; wings fuscous; Canada, New Hampshire west to Montana, Idaho, Washington, British Columbia, Oregon, and California.

Hedychridium dimidiatum (Say), 3.5–5 mm. long; varying from metallic bright green and blue to dull black; New England west into Montana, Colorado, Idaho, Washington, British Columbia, Oregon, and California.

H. viride (Cresson), 5 mm. long; green with gold and blue reflections; Mexico northward into New Mexico, Colorado, Montana, Utah, British Columbia, Washington, Oregon, and California.

[1] E. T. Cresson, "*Chrysididæ* of Colorado Ty." *Proc. Ent. Soc. Philad.*, 4, pp. 303–313, 1865.
E. Norton, "Chrysides of N. A." *Trans. Am. Ent. Soc.*, 7, pp. 233–342, 1879.
S. F. Aaron, "N. A. *Chrysididæ*." *Trans. Am. Ent. Soc.*, 12, pp. 209–248, 1885.
H. L. Viereck, "N. A. Cuckoo Wasps of the Genus *Parnopes*." *Trans. Am. Ent. Soc.*, 30, pp. 245–250, 1904.
H. Bischoff, "Mon. of *Chrysididæ*." *Genera Insectorum Fasc.*, 151, pp. 1–86, 1913.

Hedychrum violaceum Brullé, 5–13.5 mm. long; variable in color and size; brilliant green to purple or dark blue; occurs throughout North America and common in all the Western States, and quite abundant in California.

Chrysidea verticalis (Patton) (*Chrysis*), 4–6 mm. long; green to dark purple; occurs throughout the east, and west into Colorado, Idaho, Washington, British Columbia, Oregon, and California.

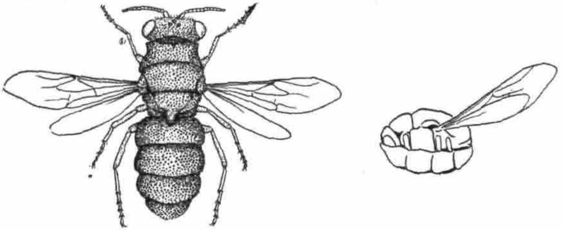

FIG. 732.—Edward's cuckoo wasp, *Parnopes edwardsi* Cresson. Right shows adult curled up into natural position when disturbed.

Holochrysis pacifica (Say) (*Chrysis*), 6–12 mm. long; emerald brassy green to blue; Eastern States, Colorado, Idaho, Washington, British Columbia, Oregon, and California.

H. hilaris (Dahlbom) (*Chrysis*), 5.5–8 mm. long; green, blue, or purple; Eastern States and throughout the entire west.

Tetrachrysis lauta (Cresson) (*Chrysis*), 7–10 mm. long; with great variations, emerald green, brassy, blue, purple, or dark; occurs throughout the entire west.

Hexachrysis clara (Cresson) (*Chrysis*), 10 mm. long; emerald to dark green with brassy or bluish reflections; throughout the entire west.

Parnopes edwardsi Cresson (Fig. 732), 6–12 mm. long; brilliant green to deep blue; California, Oregon, Washington, and British Columbia.

SPHECOIDEA [1] (Superfamily)

Bee-like Solitary and Colonial Wasps

The *Sphecoidea* consist of wasps which nest in colonies or which are more often solitary. They provision their nests with spiders, grasshoppers, leafhoppers and other homopterous insects, flies, caterpillars, bees, or other insects, and are largely beneficial in habits.

KEY TO FAMILIES [2]

1. Mesosternum produced posteriorly into an elongate process which is cleft or bifurcate apically; notauli present; mid tibiæ with two apical spurs; prothorax long; propodeum long; femora swollen near middle; prepectus present .... **Ampulicidæ**
   Mesosternum not produced into an elongate process; notauli wanting; prothorax usually transverse; femora normally not swollen in the middle 2

2. Prepectus present .... **Sphecidæ** p. 871
   Prepectus wanting 3

[1] H. S. Smith, "*Sphegidæ* of Nebraska." *Univ. Stud. Nebr.*, 8, pp. 323–410, 1908. S. A. Rohwer, *Hym. Conn.*, pp. 645–697, 1916.
P. Cameron, "*Sphegidæ*," etc. *Biol. Centr. Am. Hym.*, 2, pp. 1–157, 1888–1900.

[2] After S. A. Rohwer, *Hym. Conn.*, p. 645, 1916.

3. Antennæ inserted close to clypeus; cheeks narrow; first abdominal segment not narrower than second; lower posterior margin of propodeum angled due to metathoracic pleural suture being dorso-ventral; no dorsal plate to mesepisternum **Bembicidæ** p. 876

   Antennæ inserted much above clypeus; cheeks broad; first abdominal segment much narrower than second; lower posterior margin of propodeum rounded due to metathoracic pleural suture being curved; a dorsal plate to mesepisternum. . . . . **Cerceridæ**

SPHECIDÆ.[1] Sphecid or Thread-Waisted Wasps.

This family includes the majority of species in the superfamily. The members are distinguished by the presence of a prepectus in some form. They are solitary, nest in the soil, and provision the nests with spiders or insects.

KEY TO SUBFAMILIES[2]

1. Prepectal suture originating below lower margin of prothoracic tubercule, prepectus therefore wanting between tubercule and tegula . . . . **Nyssoninæ**[3]

   Prepectal suture originating posterior to prothoracic tubercule, prepectus therefore present between tubercule and tegula 2

2. Prepectus defined posteriorly by a strong carina which is angulate opposite prothoracic tubercule; an oblique suture from below tegula to sternum, where it joins prepectal carina 3

   Prepectus defined posteriorly by a suture; no suture from below tegula to prepectal suture 5

3. Antennæ inserted near middle of face; mesepisternum with a dorsal and ventral plate; abdomen petiolate; wings with three cubital cells . . . . **Pseninæ**[4]

   Antennæ inserted very close to dorsal margin of clypeus; mesepisternum without a dorsal plate; abdomen sessile, or subsessile; wings with one cubital cell . . 4

4. First cubital and first discoidal cells confluent; propodeum with a process at dorsal middle; metanotum with processes at sides; eyes with their inner margins subparallel . . . . **Oxybelinæ**[5]

   First cubital and first discoidal cells separate; propodeum and metanotum without processes; eyes with their inner margins strongly converging below . . . . . . **Crabroninæ** p. 872

5. Abdomen with a strong constriction between first and second ventral segments . . 6

   Abdomen without a constriction between first and second ventral segments 8

[1] E. T. Cresson, "California *Sphegidæ*." *Proc., Ent. Soc. Philad.*, 4, pp. 455–644, 1865.
S. A. Rohwer, "*Sphecidæ*." *Hym. Conn.*, pp. 652–691, 1916.

[2] After S. A. Rohwer, *Hym. Conn.*, pp. 652–653, 1916.

[3] E. T. Cresson, "Cal. *Nyssonidæ*." *Proc. Ent. Soc. Philad.*, 4, pp. 472–475, 1865.
A. S. Packard, "N. A. *Nyssonidæ*." *Ibid.*, 6, pp. 39–115, 353–445, 1866.
J. C. Bradley, "N. A. *Nyssonidæ*." *Trans. Am. Ent. Soc.*, 46, pp. 113–132, 1920.
S. A. Rohwer, "Notes on *Nyssoninæ*." *Proc. U. S. Nat. Mus.*, 59, pp. 403–413, 1922.

[4] W. J. Fox, "Species of *Psen* of Am. North of Mexico." *Trans. Am. Ent. Soc.*, 25, pp. 1–18, 1898–9.
H. L. Viereck, "New Species of *Pseninæ*." *Trans. Am. Ent. Soc.*, 27, pp. 338–342, 1900–1901.

[5] Chas. Robertson, "Syn. N. A. Species of *Oxybelus*." *Trans. Am. Ent. Soc.*, 16, pp. 77–85, 1889.
S. A. Rohwer and T. D. A. Cockerell, "Some Oxybeline Wasps from New Mexico." *Ent. News*, 19, pp. 179–180, 1908.

6. Clypeus with a lobe at dorsal middle; antennæ inserted well above clypeus near middle of face; intermediate tibiæ with two apical spurs....... **Philanthinæ** [1]
   Clypeus with dorsal margin nearly straight; antennæ inserted very close to dorsal margin of clypeus, much below middle of face.......................... 7

7. Inner margins of eyes deeply emarginate; intermediate tibiæ with one apical spur.. **Trypoxyloninæ** [2]
   Eyes at most reniform, mesal margins subparallel; intermediate tibiæ with two apical spurs.. **Mellininæ**

8. Intermediate coxæ without a transverse suture near base; propodeum long, with spiracles well removed from base; abdomen with a long petiole; intermediate tibiæ with two apical spurs.................................... **Sphecinæ**
   Intermediate coxæ with a transverse suture near base; propodeum shorter, and with spiracles close to metanotum; abdomen usually sessile, but, when petiolate, intermediate tibiæ have only one spur.............................. 9

9. Metasternum with a large process which is deeply emarginate ventrally; intermediate tibiæ with one apical spur; wings with three cubital cells; radial cell with an appendage.. **Larrinæ** [3]
   Metasternum without a large, deeply emarginate process..................... 10

10. Abdomen depressed, dorsal surface flattened; intermediate tibiæ with two apical spurs; radial cell truncate; wings with three cubital cells......... **Astatinæ**
   Abdomen cylindrical or in a very few cases subdepressed, dorsal surface convex; intermediate tibiæ with one apical spur; venation various. . **Pemphredoninæ** p. 876

CRABRONINÆ [4] (Subfamily). Crabronid Wasps. This is a rather small species ranging from 3–15 mm. in length, and varying from wholly black to black with yellow markings. The wasps nest in the soil or in tunnels in wood and store the nests with spiders and various insects.

Crabro latipes (Smith) (*Thyreopus, T. coloradensis* Packard) is 8–10 mm. in length, black with portions of the legs, thorax, and the abdomen marked with yellow and the mesosternum with pale pubescence. This wasp occurs in boreal North America and in the high mountains from Arizona north into Colorado and Montana and also in Oregon Washington, and British Columbia.

SPHECINÆ (Subfamily). Thread-Waisted Wasps or Mud Dauber. These wasps are medium-sized to quite large and have the inner margins

[1] E. T. Cresson, "N. A. *Philanthidæ*." *Proc. Ent. Soc. Philad.*, 4, pp. 49–64, 1865; 5, pp. 85–132, 1865.
H. L. Viereck and T. D. A. Cockerell, "*Philanthidæ* of New Mexico." *Jour. N. Y. Ent. Soc.*, 12, pp. 129–146, 1904.

[2] W. J. Fox, "Am. *Trypoxylon*." *Trans. Am. Ent. Soc.*, 18, pp. 136–148, 1891.

[3] E. T. Cresson, "California *Larridæ*." *Proc. Ent. Soc. Philad.*, 4, pp. 464–467, 1865.
W. J. Fox, "Mon. N. A. Species of *Tachytes*." *Trans. Am. Ent. Soc.*, 19, pp. 234–252, 1892.
S. A. Rohwer, "Some Larrid Wasps from Colorado." *Ent. News*, 19, pp. 220–224, 1908.
F. X. Williams, "Mon. *Larridæ* of Kansas." *Bul. Kan. Univ.*, 15, Sci. Bul. 8, pp. 117–213, 1914.

[4] E. T. Cresson, "California *Crabronidæ*." *Proc. Ent. Soc. Philad.*, 4, pp. 475–488, 1865.
A. S. Packard, "N. A. *Crabronidæ*." *Ibid.*, 6, pp. 64–115, 353–382, 1866.
W. J. Fox, "*Crabronidæ* of Boreal America." *Trans. Am. Ent. Soc.*, 22, pp. 129–226, 1895.
S. A. Rohwer, "Some *Crabronidæ* from Colo. and N. Mex." *Ent. News*, 19, pp. 245–259, 1908.

of the eyes parallel or subparallel; the pronotum transverse; the propodeum long; and the abdomen always petiolate. The color is usually black with yellow or reddish markings, but some of the familiar western species are metallic steel blue. They nest in the ground or build mud cells and provision their nests with spiders, grasshoppers, caterpillars, and other insects.

Chlorion atratum (Lepeletier) (*Sphex*) is robust, black throughout, 18–20 mm. long, and recorded in New York and in New Mexico, Colorado, Arizona, and Southern California. It provisions its nests with young grasshoppers. According to H. E. Smith[1] the bembicid, *Megastizus unicinctus* Say, digs open the nest, destroys the egg, and oviposits on the stored grasshoppers which it will not collect for itself. *Chlorion læviventris* (Cress.) is a very similar species often mistaken for the preceding in California and probably other Western States. *C. cyaneum* (Dahlbom) is 20 mm., long, brilliant blue-green with violaceous wings. It occurs in Washington. *C. elegans* (Smith) (*Sphex, Isodontia*), is 12 mm. in length, dark brownish throughout and clothed with white pile. It occurs in New Mexico, Colorado, Utah, Arizona, Nevada, and California. It stores its mud cells with spiders, and the immature stages are parasitized by the tachinid fly, *Pachyophthalmus floridensis* Townsend, in Southern California. *C. ferrugineum* (Fox) (*Sphex, Prionony x*) is 19 mm. long, very slender, pale reddish brown, and clothed with dull white and yellow pile. It ranges in northern Mexico, New Mexico, Arizona, and Southern California.

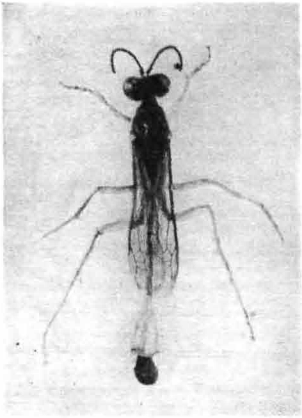

FIG. 733.—The thread-waisted wasp, *Sphex nigricans* (Dahlbom).

The steel blue mud dauber, *Sphex* (*Psammophila*) *luctuosa* Smith is 12–15 mm. long, and dark metallic steel blue throughout. It is very common in California and ranges east to the Atlantic. *Sphex* (*P.*) *violaceipennis* Lepeletier, is 12–25 mm., metallic dark blue with the basal half of the gaster reddish. It ranges from the Eastern States into Nevada and California and is a common species.

Sphex nigricans (Dahlbom) (*Ammophila*) (Fig. 733) is 12–28 mm., black or grayish; the legs largely reddish, abdomen very slender, petiole black or dusky, gaster reddish, the dorsum usually wholly or partially dusky or black. This is a very common species in California and Nevada. *S. vulgaris* (Cresson) is a similar species with black legs and the apical half of the gaster black. It occurs throughout the country and is common in Colorado, Nevada, California, and other Western States.

The blue mud wasp, *Chalybion cæruleum* (Linn.) (*Sphex, Pelopæus cæruleus* Lep., *P. californicus* Sauss., *Sceliphron cyaneum* Klug) (Fig. 734), is 12–18 mm. in length, metallic blue, blue-green, or blackish. It is common

[1] Bul. 293, *U. S. Dept. Agr. Prof. Paper*, 1915.

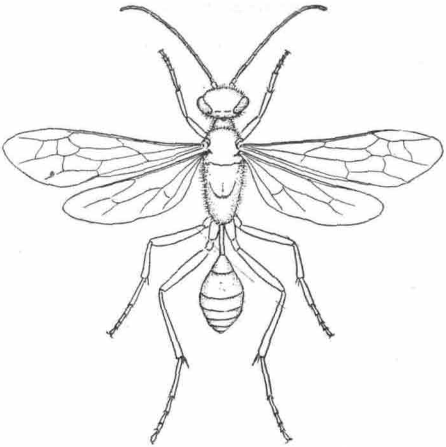

FIG. 734.—The blue mud wasp. *Chalybion cæruleum* (Linn.).

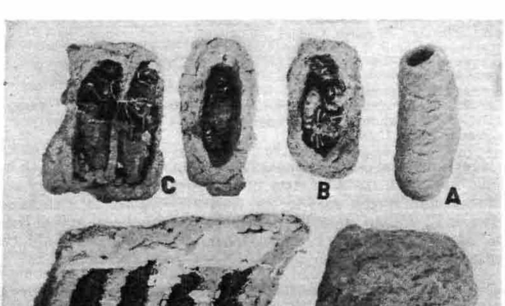

FIG. 735.—Cells of the yellow and black mud dauber, *Sceliphron servillei* (Lep.). A, uncapped cell; B, cell containing larva and spiders; C, cells containing pupæ; D, a series of cells containing pupæ removed from a whitewashed wall; E, several cells plastered over.

throughout the country and is recorded in Montana, Utah, Nevada, and California in the west. It provisions its mud cells with spiders chiefly of the genus *Epeira*.

The yellow and black mud dauber, *Sceliphron*[1] *servillei* (Lepeletier) (*Pelopæus*) (Figs. 735, 736), is 15–17 mm. long, dull black, the base of the antennæ, collar, scutellum, portion of metathorax, petiole, base of gaster, and portions of the legs bright yellow. This species builds mud nests or cells 25–35 mm. long, singly or side by side, in series of from two to six or

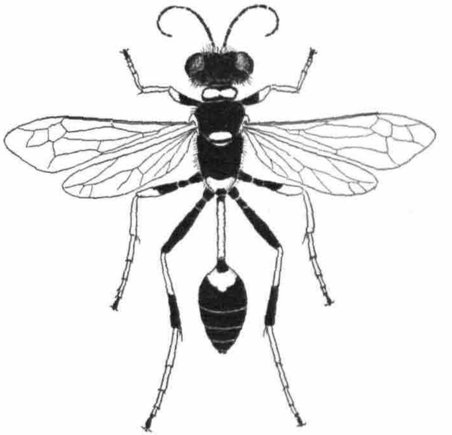

FIG. 736.—The yellow and black mud dauber, *Sceliphron servillei* (Lep.). Adult.

more, and the whole is covered with a continuous layer of mud completely obliterating the outlines of the individual cells. The nests are placed on the undersides of rocks or on logs, boards, and so forth, and are provisioned with a yellow and gray crab spider, *Misumena aleatoria* (Hentz), at Laguna Beach, California. The whitish larvæ are 10–14 mm. long. The pupæ are enclosed in thin, reddish brown, semi-transparent, capsule-like cocoons within the cells. Many cells have been found from which have been reared a larger number of parasitic tachinid flies, *Pachyophthalmus floridensis* Townsend,[2] the adults of which emerge through a round hole cut through the end of the cell. This species is similar in habits to *Sceliphron cæmentarius* Drury, which occurs throughout boreal North America.

[1] J. C. Huston, "N. A. Species of *Sceliphron*." *Trans. Am. Ent. Soc.*, 45, pp. 203–227, 1919.
[2] E. O. Essig, *P. C. Jour. Ent. and Zoöl.*, 14, p. 78, 1922.

PEMPHEREDONINÆ [1] (Subfamily). Pemphredonid Wasps. These are mostly small, slender, shining black, active wasps which build their nests in the pith or hollow stems of plants, in rotten wood or in the old galleries of wood-boring insects, and in old oak galls. The nests are provisioned with aphis, flies, and other small insects.

Pemphredon errans Rohwer measures 7 mm., and is black with hyaline wings. It has been reared from oak galls in the Sierras and also along the coast of middle California by F. B. Herbert.

BEMBICIDÆ [2] (*Bembecidæ*). Bembicid Wasps.

The bembicid wasps are characterized by the bee-like form and the absence of the prepectus. They are solitary wasps which nest in the ground and provision their nests with *Diptera* or rarely with *Homoptera*. In most cases only the first host is paralyzed, and in some, only dead insects are furnished as food for the young. The subfamily *Stizinæ* has a small labrum and two apical spurs on the middle tibiæ, while the *Bembicinæ* have a large labrum and but one apical spur on the middle tibiæ. The species herein described belong to the latter.

Bembix amœna (Handlirsch) (*Bembex*) is 15–22 mm. long, black covered with thick whitish pile. The males are largely black, the abdomen immaculate or with from one to five broken pale crossbands, while the females have the abdominal crossbands entire or nearly so except at the base, and are bright yellow or pale. This large species is common in Colorado, Utah, Nevada, California, Oregon, Washington, and British Columbia. *B. comata* Parker (Fig. 737) measures 10–17 mm. in length, and is very much like the preceding species in color but considerably smaller. It is a very common species in the west and is known in New Mexico, Arizona, California, Oregon, Washington, and British Columbia. The burrows extend down obliquely into the sand from 16 to 20 inches and branch about four inches beneath the surface forming an inverted "Y." The nest is located in one of the branches and is provisioned with from 10 to 15 flies chiefly of the families *Muscidæ* and *Sarcophagidæ*. The entrance is closed with sand. It commonly nests along the seashore. *B. occidentalis* (Fox) (*Bembex*) is 16–20 mm. long and largely yellow, with black on the head, thorax, and abdomen. It occurs in Lower California, Mexico, New Mexico, Texas, Arizona, and California.

Microbembex monodonta Say is 8–14 mm. long, black, the abdomen wholly yellow or with from 1–5 black bands, the wings often infumated. It nests in sandy places and makes a single burrow which is provisioned with dead insects which are gathered on the sands, and does not follow the general practice of capturing live prey and paralyzing it in order to provide a fresh supply of food for the young. The nests are not provisioned until the eggs hatch, after which new stores are brought over a period of several days. The young

[1] A. S. Packard, "N. A. *Pemphredoninæ*." *Proc. Ent. Soc. Philad.*, 6, pp. 383–396, 1886–1887.

W. J. Fox, "N. A. *Pemphredonidæ*." *Trans. Am. Ent. Soc.*, 19, pp. 307–324, 1892.

S. A. Rohwer, "N. A. Wasps of the Subgenus *Pemphredon*." *Bul. Brooklyn Ent. Soc.*, 12, pp. 99–102, 1917.

[2] E. T. Cresson, "California *Bembicidæ*. *Proc. Ent. Soc. Philad.*, 4, pp. 467–472, 1865.

S. A. Johnson and S. A. Rohwer, "Colorado *Bembicidæ*." *Ent. News*, 19, pp. 373–380, 1908.

S. A. Rohwer, "Bembecid Wasps of Boulder County, Colo." *Univ. Colo. Stud.*, 6, pp. 243–248, 1909.

J. B. Parker, "Rev. Bembicine Wasps of Am. North of Mex." *Proc. U. S. Nat. Mus.*, 52, pp. 1–155, 1917.

T. D. A. Cockerell, "The Bembicine Wasps." *Ent. News*, 29, pp. 59–60, 1918.

are frequently attacked by dipterous and hymenopterous parasites. This species occurs commonly in the Eastern and middle States and ranges west into Utah, California, and Lower California. *M. aurata* Fox is 12–14 mm. long, black and yellow, while the clypeus, scape, mesopleura, and large discal spots on the scutum are yellow. It occurs

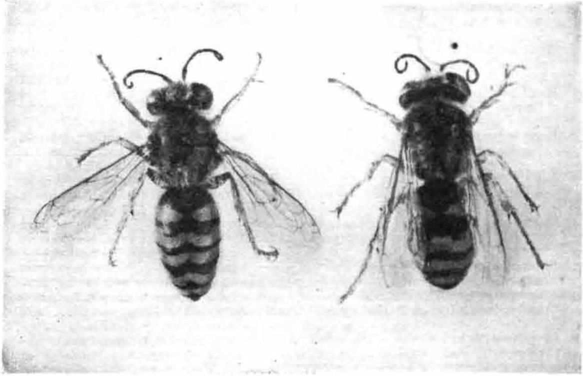

FIG. 737.—The long-haired bembicid wasp, *Bembix comata* Parker. Adults.

in Arizon, California, Utah, and Lower California. *M. hirsuta* Fox is 9–13 mm. long, black with greenish yellow markings, and distinguished by the long dense pubescence on the head, thorax, and median segment. It occurs in Mexico, Texas, New Mexico, and Arizona.

VESPOIDEA (Superfamily)[1]

Predaceous and Solitary Wasps

KEY TO FAMILIES[2]

1. Posterior angle of pronotum sharp and above tegula; wings folded longitudinally in repose 2
   Posterior angle of pronotum rounded or rather sharp but always in front of or below tegula; wings not folded longitudinally in repose 4

2. Antennæ distinctly thickened apically and in most species with a club; antennæ of the male longer than in the female; wings not distinctly folded longitudinally **Masaridæ** p. 889
   Antennæ never ending in a club; wings distinctly folded longitudinally 3

[1] W. H. Ashmead, "Classification of the *Vespoidea*." *Can. Ent.*, 32, pp. 145–155, 185–188, 295–296, 1900; 34, pp. 79–88, 131–137, 1902; 35, pp. 3–8, 1903. "*Thynnidæ* in the U. S." *Psyche*, 8, p. 251, 1898.
S. A. Rohwer, "C. T. Brues and H. L. Viereck." *Hym. Conn.*, pp. 606–644, 1916.
[2] After S. A. Rohwer, *Hym. Conn.*, pp. 606–607, 1916.

3. Claws dentate; two forms, males and females. (Solitary Wasps, Pottery Wasps.) **Eumenidæ**[1]
   Claws simple; three forms, females, males, workers . . . . **Vespidæ** p. 884

4. No constriction between first and second abdominal segments; discoidal cells obsolete, or if the first is present it is petiolate 5
   A constriction between first and second abdominal segments which is usually deep; at least first discoidal cell well defined, not petiolate 6

5. Head oblong; antennæ with twelve or more joints; stigma lanceolate; fore tarsi of female never chelate. Parasitic on larvæ of *Lepidoptera* and *Coleoptera* . . . . **Bethylidæ**
   Head transverse, subquadrate or globose; antennæ 10-jointed; stigma large; fore tarsi of female chelate . . . . **Dryinidæ**

6. Legs very long, posterior femora when directed backward extending beyond middle of abdomen; mesepisternum with a dividing cephalocaudal suture . . . . **Psammocharidæ** p. 882
   Legs of usual length, posterior femora when directed backward not reaching to middle of abdomen; mesepisternum without a dividing cephalocaudal suture . . 7

7. Sternellum large, sharply defined, extending between intermediate coxæ so they are well separated; females winged; tibiæ usually flattened with bristles exteriorly **Scoliidæ** p. 880
   Sternellum not defined; intermediate coxæ contiguous; or, if coxæ are somewhat separated, readily distinguished from the preceding family by not having sternellum separated from eusternum by a transverse suture; tibiæ not flattened and without a single rugose area; if rugose, nearly uniformly so 8

8. Clypeus with length and width subequal or nearly so; female winged; apex of abdomen in male without appendages; eyes deeply emarginate. Parasitic on bees and sphecoid wasps . . . . **Sapygidæ**
   Clypeus transverse, very much wider than long; apex of the abdomen in male armed or unarmed; eyes usually entire 9

9. Female thorax divided into three parts; apex of abdomen in male armed with a single spine . . . . **Methocidæ**
   Female thorax divided into two parts, prothorax being well separated; apex of abdomen in male without spines . . . . **Myrmosidæ**[2]
   Female thorax undivided; apex of abdomen in male with two spines **Mutillidæ** p. 881

DRYINIDÆ. Dryinid Wasps.[3]

Gonatopus contortulus Patton (Figs. 738, 739) have the females ant-like, wingless, with large front legs and front claws large and pincer-like, thorax slender, antennæ 10-jointed, 3–4 mm. long, shining black, two basal joints yellow, the remainder and also the legs reddish. The males are winged. The larval sac is oval, shining black, and occurs on the abdomen of the

[1] K. W. von Dalla Torre, *Genera Insectorum Fasc.*, 19, pp. 9–61, 1904.
P. Cameron, "*Odyneridæ* of the Southwest U. S." *Trans. Am. Ent. Soc.*, 34, pp. 195–228, 1908.
D. Isely, "Syn. Family *Eumenidæ*. in Am. North of Mexico." *Ann. Ent. Soc. Am.*, 10, pp. 345–366, 1917.

[2] J. C. Bradley, "Rev. of the *Myrmosidæ*." *Trans. Am. Ent. Soc.*, 43, pp. 247–290, 1917.

[3] W. H. Ashmead, *Dryininæ*. Bul. 45, U. S. Nat. Mus., pp. 80–102, 1893.
J. J. Kieffer, "*Dryinidæ*." *Genera Insectorum Fasc.*, 54, pp. 1–33, 1906.
R. C. L. Perkins, "Parasites of the Family *Dryinidæ*." *Haw. Sugar Planters' Assoc. Exp. Sta. Ent. Ser. Bul.*, 11, pp. 1–18, 1912.
C. T. Brues, *Hym. Conn.*, pp. 613–616, 1916.
F. A. Fenton, "Parasites of Leafhoppers." *Ohio. Jour. Sci.*, 18, pp. 177, 243, 1918.

host; the cocoon is oval, white, 4.5 x 0.5 mm., and is spun on grasses or other plants. The females are very active and stalk their prey which is

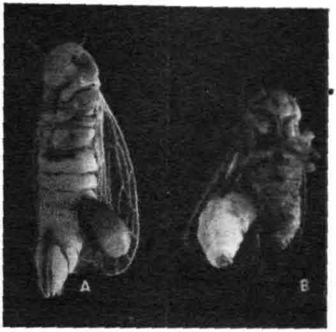

FIG. 738.—The contort dryinid wasp, *Gonatopus contortulus* Patton. A, larva within larval sac, protruding from between two abdominal segments; B, larva leaving sac and host prior to pupation on the foliage of a plant. The host is the sugar beet leafhopper, *Eutettix tenellus* (Baker). (After Severin.)

seized with the strong front legs and held while the egg is inserted in the body, usually in the venter. The females are also predaceous and devour a great many leafhoppers and are considered by some to be more bene-

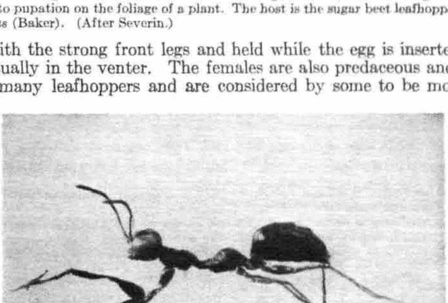

FIG. 739.—Adult female of the contort dryinid wasp, *Gonatopus contortulus* Patton. (After Severin.)

ficial as predators than as parasites. They are parthenogenetic as well as sexual. There are two generations and the winter is spent as larvæ in

the small white cocoons. The species occurs throughout the United States and is parasitic and predaceous on *Deltocephalus sayi* (Fitch) and *D. oculatus* O. & B. in the east and on *Eutettix tenellus* (Baker) in California.

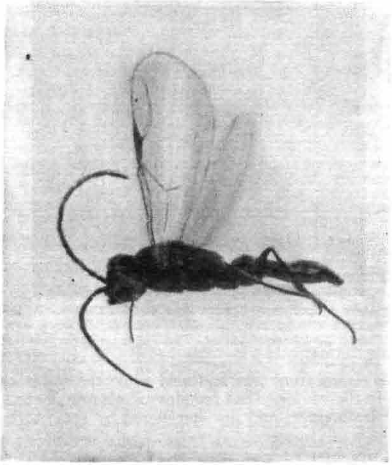

FIG. 740.—Adult male of the contort dryinid wasp, *Gonatopus contortulus* Patton. (After Severin.)

Gonatopus ombrodes (Perkins) (*Mogonatopus*) is a similar species parasitic and predaceous on *Cicadula sexnotata* (Fallén) in Colorado.[1]

Gonatopus californicus Ashm. has the female of the species 3 mm. in length, the head and thorax reddish brown, abdomen black, the antennæ, tarsi, middle of the tibiæ and portion of hind femora yellow. It is taken in California without host records.

SCOLIIDÆ.[2] Scoliid Wasps.

These are large wasps with stout legs, in which the middle tibiæ have one spur, large head, usually strongly emarginate eyes, short antennæ, with a constriction between the first and second sternites, and wings with well developed venation, the veins not reaching the apical margin which is characteristically striated. The colors are usually blackish with yellow or red spots and bands. The wasps apparently do not build nests and store food, but lay their eggs near or on the host. Those with known habits are

[1] C. N. Ainslie, *Ent. News*, 30, pp. 169, 187, 1920.

[2] E. T. Cresson, "*Scoliadæ* from Colorado Ty." *Proc. Ent. Soc. Philad.*, 4, pp. 442–450, 1865.

N. Banks, "*Scoliidæ*." *Can. Ent.*, 44, pp. 199–201, 1912.

largely parasitic on white grubs or the larvæ of *Scarabæidæ*. There are a number of western species, the host relationships of which are unknown.

MUTILLIDÆ.[1] Mutillids, Mutillid Wasps or Velvet Ants.

This is a large family of medium-sized, brightly colored insects in which the males are normally winged and the female wingless. The males have 13-jointed antennæ and the females, 12. The bodies of both sexes are black and clothed with thick, short, white, yellow, golden, orange, or bright red hairs often in combination with black hairs. The females have a very effective sting and make a queer squeaking noise when held by the body. The mutillids are most abundant in the tropical and sub-tropical regions and are numerous in the Southwestern States, but range in limited

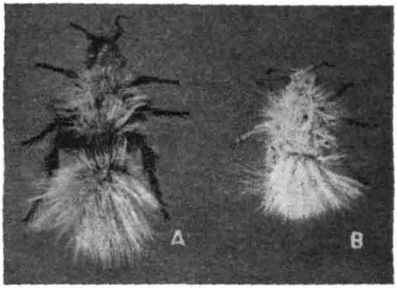

FIG. 741.—Mutillid wasps or velvet ants. A, *Mutilla sackeni* Cresson; B, *Mutilla gloriosa* Saussure.

numbers north into British Columbia. Some species are supposed to dig nests in the soil and provision them with insects but most are believed to be parasitic in the nest of the wasps and bees. Little exact information, however, has been acquired regarding them.

Mutilla aureola Cresson has the female 12–13 mm. in length, the head quadrate and wider than the thorax, black, the dorsum of head, thorax, and abdomen golden yellow. This is a common species on the dry grassy hillsides of middle California, particularly

[1] E. T. Cresson, "Mutilla from California." *Proc. Ent. Soc. Philad.*, 4, pp. 385–390, 1865. *Trans. Am. Ent. Soc.*, 5, pp. 119–120, 1874.

C. A. Blake, "Syn. N. A. *Mutillidæ*." *Trans. Am. Ent. Soc.*, 3, pp. 217–265, 1870; 4, pp. 71–76, 1872. "Cat. *Mutillidæ* of N. A." *Ibid.*, 7, pp. 243–254, 1879. "Mon. *Mutillidæ* of N. A." *Ibid.*, 13, pp. 179–286, 1886.

P. Cameron, "*Mutillidæ*." *Biol. Centr. Am. Hym.*, 2, pp. 259–402, 1888–1900.

W. J. Fox, "N. A. *Mutillidæ*." *Trans. Am. Ent. Soc.*, 25, pp. 219–300, 1899.

E. André, "*Mutillidæ*." *Genera Insectorum Fasc.*, 11, pp. 1–77, 1902.

A. L. Melander, "Notes on N. A. *Mutillidæ*." *Trans. Am. Ent. Soc.*, 29, pp. 291–330, 1903.

J. C. Bradley, "Mon. of *Mutillidæ* and Allies of N. A." *Trans. Am. Ent. Soc.*, 42, pp. 187–214, 309–336, 1916.

C. E. Mickel, "Rev. of Genera *Myrmilloides* and *Pseudomethoca* in N. A." *Proc. U. S. Nat. Mus.*, 64, art. 15, pp. 1–51, 1924.

in Alameda and Contra Costa Counties, and also occurs in the Sierra foothills. *M. bioculata* Cresson has the male 18–27 mm. long, black, the thorax and abdomen reddish above. It occurs in New Mexico, Arizona, Colorado, and California. *M. californica* Radoszkowski (*Sphærophthalma*) has the female 8–14 mm. long, black, the dorsum of the head thorax, and the abdomen, except the base, brick red. It ranges in New Mexico, Colorado, and California. *M. gloriosa* Saussure (Fig. 741, B) has the female 13–16 mm. in length, black, clothed with long white hairs, and commonly known as the thistle down mutillid. It also occurs in New Mexico, Arizona, and Southern and Central California. *M. sackeni* Cresson (Fig. 741, A) is a similar species 13 mm. long with dense white hairs on the dorsum. It occurs in Arizona and California.

Pseudomethoca propinqua (Cresson) (*Mutilla*), in the male form measures 9 mm., is black, the dorsum of thorax black, and the vertex and apical margins of the abdominal segments golden and the wings dark. The female is similarly colored and 8–12 mm. long. The female has been described as *Mutilla montivaga* Cress. This species occurs in New Mexico, Colorado, Montana, and California.

PSAMMOCHARIDÆ[1] (*Pompilidæ*). Spider Wasps.

These are medium-sized to large black, metallic dark blue or reddish wasps which are very active on the ground and take short restless flights. The antennæ are long and often curled in mounted females; the wings hyaline, infuscated or iridescent; the hind legs very long. They usually

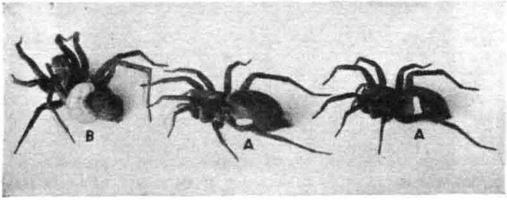

FIG. 742.—The steel-blue spider wasp, *Psammochares luctuosus* (Cresson). A, eggs; B, larva attached to the bodies of the spider, *Lycosa pratensis* Emerton, which were taken from a wasp nest in the ground. (Photo furnished by C. T. Dodds.)

nest in subterranean cells, provisioned with spiders which are first stung and rendered helpless by the female. At least one species is thought to be parasitic in the nests of other wasps. There are many western species, but little is known regarding their exact habits.

Psammochares luctuosus (Cresson) (*Pompilus*) (Fig. 742) is 10–12 mm. long, the legs very long, metallic blue-black, the wings infuscated and with violet iridescence. It ranges throughout boreal North America and is common in the west, occurring in the mountains and along the Pacific Coast. C. T. Dodds found the nests at Berkeley, California, stored with the spider, *Lycosa pratensis* Emerton. A single egg was placed on the side of the abdomen of the host. *Psammochares planatus* (Fox) (*Planiceps*, *Pompilus*) has been reared from the nests of the trapdoor spider, *Bothriocyrtum californicum* (Cam-

[1] E. T. Cresson, "*Pompilidæ* of N. A." *Proc. Ent. Soc. Philad.*, 4, pp. 451–454, 1865. *Trans. Am. Ent. Soc.*, 1, pp. 85–150, 1867.
W. J. Fox, N. A. Species of *Ceropales*." *Trans. Am. Ent. Soc.*, 19, pp. 49–63, 1892.
N. Banks, *Jour. N. Y. Ent. Soc.*, 19, pp. 219–237, 1911. *Can. Ent.*, 44, pp. 197–199, 1912. "*Psammocharidæ* of Western N. A." *Bul. Mus. Comp. Zoöl.*, 63, pp. 229–248, 1919.
H. L. Viereck, *Hym. Conn.*, pp. 625–634, 1916.

bridge), in Southern California. The mature larva spins a web across the hole under the trapdoor and suspends the cocoon in the tube within a matrix of silk. The mature wasp gnaws a hole through the door to escape.[1]

The tarantula hawks belong to the genus *Pepsis* and are very large, metallic, velvety blue-black throughout with violaceous or bright fiery red wings. The antennæ of the females are usually coiled, while those of the males are straight, particularly in the case of mounted specimens. They prey extensively on trap-door spiders and tarantulas which are first paralyzed by stinging in the cephalic ganglia and then stored in the nests in the ground as food for the young. These wasps are largely tropical and range from South America into our region. *Pepsis formosa* Say [*P. rubra* (Drury), *P. cærulea* (Fabr.), *P. auripennis* DeGeer] (Fig. 743) is one of

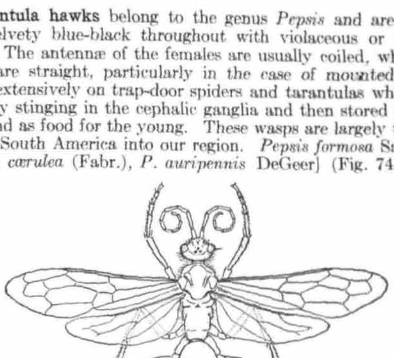

FIG. 743.—The common tarantula hawk, *Pepsis formosa* Say. Adult female.

the commonest and largest species in Mexico, Texas, New Mexico, Arizona, and Southern California, and ranges south into Brazil. It is 20–40 mm. long, steel blue and black throughout, including the antennæ, the wings fiery red with the outer and apical margins dusky. *Pepsis cinnabarina* R. Lucas is similarly colored, but has the wings an even more brilliant red and is much smaller, averaging from 20–30 mm. in length. It occurs in Mexico, Southern California, and Arizona.

Pepsis mildei Stål (Fig. 744, A) is 20–30 mm. long; metallic blue-black; the antennæ reddish, dusky at extreme base in the male and the basal third dusky in the female; the wings fiery red with the bases and apices dusky. The wings are not so bright as in the two preceding species. This wasp occurs in Northern Mexico, Arizona, and Southern California.

Pepsis obliquerugosa Lucas (Fig. 744, B) is a splendid, large, entirely metallic dark steel-blue species 30–40 mm. long, with blackish antennæ and blue-black or violaceous wings. It ranges from Mexico into New Mexico, Arizona, and Southern California.

[1] A. Davidson, *Ent. News*, 16, pp. 233–234, 1905.

Salius ustulatus (Dahlbom) (*Hemipepsis ustulata* Dahl., *Mygnimia*) is a velvety black species 12–20 mm. long and with orange or reddish wings which are dusky at the extreme bases and tips. It occurs in Mexico and ranges into Northern California from the Sierras to the Coast.

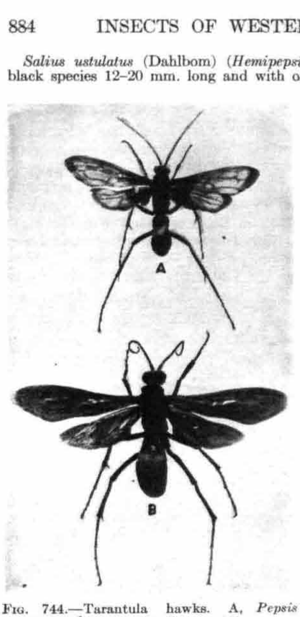

Fig. 744.—Tarantula hawks. A, *Pepsis mildei* Stål, male; B, *Pepsis obliquerugosa* Lucas, female.

VESPIDÆ.[1] Paper Wasps, Social Wasps, Yellow Jackets, Hornets.

This family comprises familiar, medium-sized, mostly yellow and black insects, which are social in habits and build large and small paper nests (Fig. 745) mostly above, but also below ground. The adults are monogamic or polygamic wasps, the females being provided with a severe sting which is used altogether too freely at times; the wings fold longitudinally; the middle tibiæ have two apical spurs and the claws are simple; the antennæ are elbowed with long scape; biting and sucking mouth parts are present; and a petiole is either present or absent. There are generally three castes; queens or fertile females, workers or sterile females, and drones or males. The latter are the product of unfertilized eggs; the queens are fed more and are larger than the workers. Workers may produce eggs which hatch only into males, but are incapable of fertilization. The queen starts the nest in the spring using wood fibre which is reduced to paper by mastication. When a few cells are completed a fertile egg is laid in each. The legless white grubs soon appear and are fed daily on insect material and sweets. When the larvæ are mature the cells are capped and pupation follows therein. Workers only are produced until fall when the sexes appear and mating occurs. The young queens hibernate and establish new colonies the following spring. The adults feed on various insects, meats, fruits, honeydew, and other sweets, and are often very troublesome about fruit canneries and drying sheds, doing considerable damage to fresh fruits. This damage is partially offset by the destruction of great numbers of house, stable, and other flies, caterpillars, and similar injurious insects. The two

[1] J. McFarland, "A Table of the Genus *Vespa* in U. S." *Trans. Am. Ent. Soc.*, 15, pp. 297–299, 1888.
H. W. Lewis, "*Vespinæ* of U. S. and Canada." *Trans. Am. Ent. Soc.*, 24, pp. 169–191, 1897.
K. W. von Dalla Torre, "*Vespidæ*." *Genera Insectorum Fasc.*, 19, pp. 1–108, 1904.
H. L. Viereck, *Hym. Conn.*, pp. 640–644, 1916.

subfamilies are separated as follows: the *Vespinæ* which do not have the abdomen petiolate and are monogamic in the nearctic species; and the

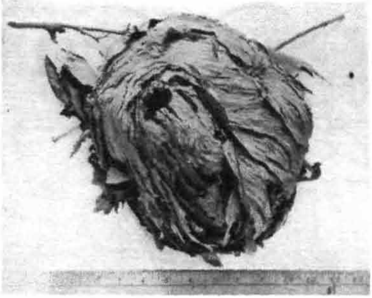

FIG. 745.—Nest of the Pennsylvania yellow jacket, *Vespula pennsylvanica* (Saussure).

Polybiinæ which have the abdomen petiolate and are monogamic in the nearctic species and polygamic in others.

VESPINÆ (Subfamily). Yellow Jackets, Hornets and Polistes Wasps. The yellow jackets and hornets are characterized by having long hind wings without an anal lobe, the abdomen conical and truncate, and by building nests which are entirely enclosed excepting a small circular opening. These nests are suspended from trees, bushes, buildings, or other objects, or are built in holes in the ground. In the latter case, according to W. B. Anderson, the mouth may be surrounded by a small clay chimney to keep out the rain water, in the Northwestern States.

FIG. 746.—Worker of *Vespula pennsylvanica* (Saussure).

The common yellow jacket, *Vespula* (*Dolichovespula*) *diabolica* (Saussure) (*Vespa*), is one of the commonest species throughout the country. It is the familiar black and yellow species in which the black usually predominates; the legs are yellow with the femora mostly black; the scape of the antennæ yellow anteriorly; and the length varies from 10–15 mm., averaging 12 mm. It frequently builds very large nests in trees and also nests in the ground. The variety *fernaldi* (Lewis) is the commonest western form, in which the yellow and black are about equal. Both the species and the variety occur throughout the west. Members of this subgenus have the eyes remote from the base of the mandibles.

The white-faced hornet, *Vespula (D.) maculata* (Linn.) (*Vespa*), is 12–19 mm. long, largely black, the face and thorax with white or pale yellow markings, the abdomen with the apical third whitish, and the scape of the

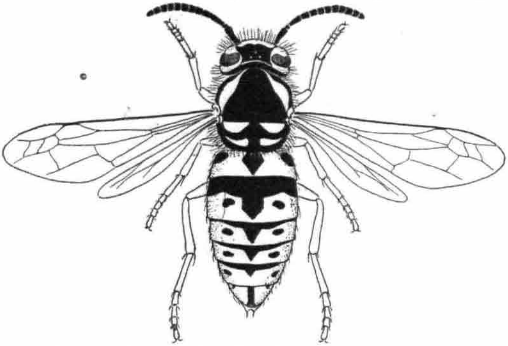

FIG. 747.—Sexual female of *Vespula pennsylvanica* (Saussure).

antennæ white anteriorly. This species occurs throughout the country and builds small or often very large nests, usually in trees. The workers are very pugnacious, but perhaps no more so than the hundreds of country boys who destroy their nests.

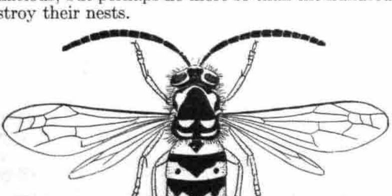

FIG. 748.—Sexual male of *Vespula pennsylvanica* (Saussure).

Vespula (D.) borealis (Kirby) (*Vespa*) is 13–15 mm. long, largely black with white or pale yellow markings on the head and thorax, and with five pale crossbands on the abdomen which are wider posteriorly. It occurs in the west in Washington and British Columbia.

Vespula (D.) marginata (Kirby) (*Vespa*) is similar to the two preceding species, being almost wholly black and having two white scutellar spots and six abdominal

rings. It also occurs in the northern parts of North America, and in British Columbia in the west.

Vespula (*Vespula*) *pennsylvanica* (Saussure) (*V. occidentalis* Cresson) (*Vespa*) (Figs. 744–748), is 12–17 mm. long, black and yellow, and the scape of antennæ yellow beneath. This species is quite as common in the west as is *V. diabolica* (Sauss.) var. *fernaldi* (Lewis). It is larger and readily distinguished by the fact that the eyes extend close to the base of the mandibles, a characteristic distinguishing the members of the subgenus *Vespula*. It occurs in all the Western States. *Vespula* (*V.*) *scelesta* (McFarland) (*Vespa*) is similar to the white-faced hornet but has the antennæ all black and the eyes extending to the base of the mandibles. It occurs in much of the United States and is reported in Colorado, Montana, Oregon, and Washington in the west. *Vespula* (*V.*) *consobrina* (Saussure) (*Vespa*) is 9–15 mm. long, black and yellow or whitish with pale lines and spots on the head and thorax, and the abdomen with a white band near

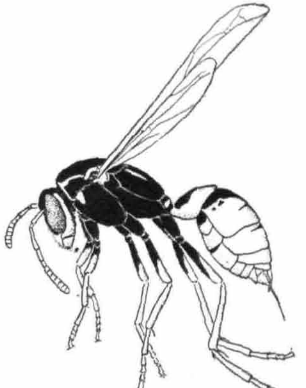

FIG. 749.—The golden polistes, *Polistes aurifer* Saussure. Adult female.

the middle, a second and wider one farther back, and the tip all white or yellow. Some forms also have a narrow band at the base of the abdomen. This species occurs throughout the country and is recorded in Colorado, Montana, and Washington in the west. *Vespula* (*V.*) *infernalis* (Saussure) (*Vespa*), is 12–15 mm. in length, and is a similarly colored species being largely black with narrow yellow bands and the tip of abdomen whitish, or with the bands lacking. It is reported in California and Oregon. *Vespula* (*V.*) *sulphurea* (Saussure) (*Vespa*) is 14–17 mm. long, largely yellow, and with two longitudinally yellow lines on the dorsum of the thorax. It is a slender species recorded in Texas, New Mexico, Arizona, Nevada, and California. *Vespula* (*V.*) *germanica* (Fabr.) (*Vespa*) has often been confused with *V. diabolica* (Sauss.) var. *fernaldi* (Lewis) and *V. pennsulvanica* (Sauss.). It is separated from both by the wholly black antennæ and by different ornamentation on the first abdominal segment. It probably occurs throughout much of our region and also frequently nests in the ground.

Polistes aurifer Saussure (Fig. 749) is the commonest western species occurring throughout our region from Colorado to the Pacific Ocean and from Arizona and Lower California into British Columbia. It is also recorded in Hawaii and Australia. The adults are 9–15 mm. long and differ

from the species of *Vespula* by the presence of a distinct lobe on the hind wings and by the spindle shaped abdomen which tapers at both ends and is never truncate at the base. The color is black and yellow, the abdomen yellow with the base of the first and second and sometimes the third black. The nests are small with exposed cells and are often attached to buildings. The adults are common about fresh fruits and water and the larvæ are fed caterpillars which are first skinned and then masticated by the adults.

Polistes bellicosus Cresson is 18 mm. long, yellow and dull reddish. It occurs in various parts of the country and in British Columbia in the west. *P. apachus* Saussure is 16–20 mm. in length, striking reddish brown with extensive yellow markings. It occurs in Mexico, Texas, and New Mexico. *P. comanchus* Saussure is a large species 16–20 mm. long, variously marked reddish, yellow, and black, and occurs in Mexico and New

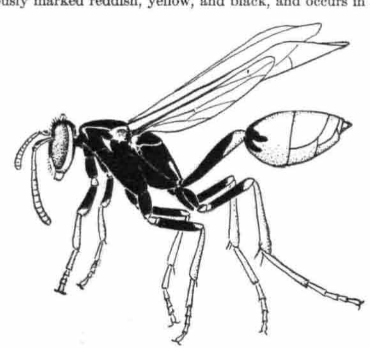

FIG. 750.—The polybia wasp, *Mischocyttarus flavitarsis* (Saussure). Adult.

Mexico. *P. flavus* Cresson is a very striking, large, bright yellow species 18–22 mm. long, with brown or violaceous wings. E. P. Van Duzee took it in great numbers about water in Arizona. It also occurs in New Mexico and Mexico. *P. pallipes* Lepeletier (*P. metricus*) Say is 17–21 mm. long, black and yellow, the abdomen black with the first segment bordered yellow posteriorly. It is common throughout the Northern States and ranges west into British Columbia. *P. texanus* Cresson is 13–15 mm. long, striking reddish brown with yellow markings, the abdomen with band near the base and the apical half yellow. It occurs in Mexico, Texas, New Mexico, Arizona, and Southern California.

POLYBIINÆ (Subfamily).

Mischocyttarus (*Myrapetra*) *flavitarsis* (Saussure) (*Polybia*) (Fig. 750), is at once separated from the two preceding genera by the slender, petiolate, basal abdominal segment and the button-shaped gaster. In other respects it is similar, colored orange-yellow, reddish, and black, and measuring 16–20 mm. in length. This is a common species in Mexico, Texas, New Mexico, Arizona, and California. It builds small, single-combed, unenveloped paper nests, usually smaller than *Polistes*, under rocks, logs, caves, banks, and in buildings. The food is largely composed of insects.

MASARIDÆ.[1] Masarid Wasps.

Pseudomasaris (*Toryna*) *vespoides* (Cresson) (*Masaris*) is the largest and most beautiful western species, measuring from 15–22 mm., and is black marked with yellow. The cells are cylindrical and built of clay in series, the mass being plastered over so as to obliterate the individual cells, which are, however, distinguishable by the depressed stopper at the top of each. The mass is elongate or globular and is usually attached to a small twig. The cells are lined with silk and provisioned with the larvæ of insects. In some instances immature forms remain in the cells and do not reach maturity until the following season. This species is recorded from South Dakota, Idaho, Colorado, New Mexico, Utah, Nevada, and California. A number of other species of this and other genera occur in the southwest.

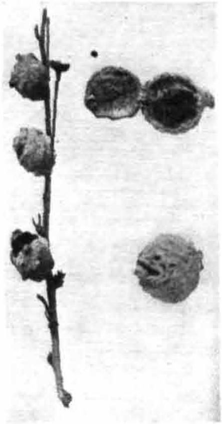

FIG. 751.—Nests or cells of the pottery wasps or jug builders belonging to the family *Eumenidæ*.

APOIDEA (Superfamily)[2]

Bees

The members of this large superfamily are of the general honeybee type and are very diverse in size, structure, color, and habits. They are separated from other *Hymenoptera* by the branched hairs on the dorsum of the thorax and by the first joint of the hind tarsi being enlarged or dilated. They are solitary, colonial, communistic, or social.

KEY TO FAMILIES[3]

1. Females and most males with a flat triangular area on apical dorsal abdominal segment 2
   Females and most males without a flat triangular area on apical dorsal abdominal segment 10

2. Clypeus hardly protuberant, and mandibles not commonly beveled; labrum concealed except at base, and provided with a basal process or raised area; posterior angle of mandible not in front of posterior margin of eye; metathorax produced beyond postscutel, in profile at least strongly convex, usually

[1] J. C. Bradley, "Taxonomy of the Masarid Wasp, Including a Monograph of the N. A. Species." *Univ. Cal. Pub. Tech. Bul.* 1, No. 9, pp. 369–484, pls. 2–16, 1922.

[2] E. T. Cresson, "N. A. *Hymenoptera*." *Trans. Am. Ent. Soc.*, 7, pp. 61–136, 201–232, 1878–79.

W. H. Ashmead, "Classif. of *Apoidea*." *Trans. Am. Ent. Soc.*, 26, pp. 49–100, 1899.

T. D. A. Cockerell & W. W. Robbins, "Rocky Mt. Bees." *Univ. Colo. Studies*, 7, No. 3, pp. 179–195, 1910.

[3] After Charles Robertson as modified by H. L. Viereck in *Hym. of Conn.*, pp. 698–699, 1916.

with posterior and a dorsal space; tongue acute, flat, rarely filiform; labial palpi with first joint varying in size and shape but with second, third, and fourth joints simple.......... 3
Clypeus protuberant, or mandibles beveled so as to show all of labrum or a great portion of it; labrum large, without a basal process; posterior angle of mandible before posterior line of eye; thorax in profile declining beyond scutel; postscutel on posterior face of thorax, metathorax at most a little convex; tongue filiform; first and second joints of labial palpi flat.......... 7

3. Labrum not free from mandibles and not so large as clypeus.......... 4
Labrum free from mandibles and as large as clypeus..........**Dufoureidæ**

4. Hind metatarsus invariably narrower than tibia.......... 5
Hind tibia and metatarsus of equal breadth..........**Macropidæ**

5. Marginal cell acute toward front edge of wing.......... 6
Marginal cell truncate toward front edge of wing..........**Panurgidæ**

6. Basal vein forming more or less perfectly an arc of a circle; face with no pubescent depressions or foveæ..........**Halictidæ**
Basal vein forming a more or less perfectly straight line; face with pubescent depressions or foveæ, at least in female..........**Andrenidæ** p. 891

7. First portion of subdiscoidal vein distinctly longer than third portion of discoidal vein.......... 8
First portion of subdiscoidal vein shorter than third portion of discoidal vein.. **Nomadidæ** p. 891

8. Marginal cell bent away from costal vein.......... 9
Marginal cell not bent away from costal vein..........**Anthophoridæ** p. 892

9. Vertex crested..........**Euceridæ**
Vertex not crested..........**Emphoridæ**

10. Second recurrent vein bent or directed outward before joining first portion of subdiscoidal vein; tongue flat, bilobed; depressions or foveæ on face.......... 11
Second recurrent vein never strongly bent or directed outward before joining first portion of subdiscoidal vein; tongue filiform; no depressions or foveæ on face.......... 12

11. Wings with two closed submarginal cells; black with yellow markings.......... **Hylæidæ** p. 892
Wings with three closed submarginal cells; black without yellow markings.... **Colletidæ** p. 893

12. Wings with two submarginal cells.......... 13
Wings with three submarginal cells.......... 14

13. Claws cleft, inner tooth subapical..........**Stelididæ**
Claws simple, or in some species with a basal tooth..........**Megachilidæ** p. 893

14. Apex of sixth dorsal abdominal segment in female with a spine.......... 15
Apex of sixth dorsal abdominal segment in female without a spine; first submarginal cell shorter than second; cheek or malar space distinct....**Apidæ** p. 898

15. First submarginal cell longer than second, and as long as third...**Ceratinidæ** p. 896
First submarginal cell shorter than second..........**Xylocopidæ** p. 897

HALICTIDÆ.[1] Sweat Bees.

The sweat bees are a small species ranging from 5–16 mm. in length, mostly black with metallic blue, green, brass, or copper iridescence; a few

[1] T. D. A. Cockerell, "Bees of the Genus *Halictus*." *Trans. Am. Ent. Soc.*, 24, pp. 163–168, 1897.
J. C. Crawford, "Genus *Halictus*." *Jour. N. Y. Ent., Soc.*, 15, pp. 183–189, 1907.

are mostly or partially red or yellow. They are often communal in nesting habits, building in the soil in common a main entrance and burrow, from which each individual may construct side galleries for its cells. The nests are frequently made in sand banks. The adults visit flowers and collect nectar and pollen to provision the brood cells. The females sometimes hibernate. The family is beneficial because of the pollination of the blossoms of fruit trees and other plants.

ANDRENIDÆ.[1] Acute-tongued Burrowing Bees.

These are small bees ranging from 6–18 mm. in length, mostly metallic black, some reddish or brownish; the glossa or tongue is shorter than the mentum and there is dense pubescence on the head and thorax (Fig. 752). They are solitary or colonial in habits, the individual females constructing their own burrows and cells in the ground and provisioning the latter with

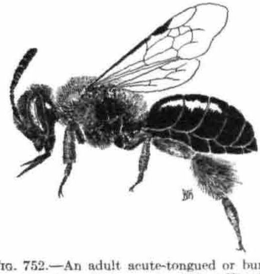

FIG. 752.—An adult acute-tongued or burrowing bee, *Andrena* sp. (After Woodworth.)

FIG. 753.—The California cuckoo bee, *Melecta californica* Cresson. (After Woodworth.)

nectar and pollen. Both sexes remain in the nests throughout the late summer and winter and emerge in the spring. Like the preceding family, it is beneficial because of the pollination of plants.

NOMADIDÆ.[2] Cuckoo Bees.

This family comprises small bees 10–14 mm. long, or less, wholly or partially black or reddish, or bright metallic blue or green marked with yellow (Fig. 753). These bees live as guests or inquilines in the nests of other bees, often those of the family *Andrenidæ*. The females appear in the spring and lay eggs, cuckoo-like, in the provisioned nests of other bees. The guest lava often hatches first, and feeds more rapidly than the host

[1] W. H. Ashmead, "*Andrenidæ*." *Trans. Am. Ent. Soc.*, 26, pp. 86–93, 1899.
Chas. Robertson, "Syn. *Andreninæ*." *Trans. Am. Ent. Soc.*, 28, pp. 187–194, 1902.
L. Bruner, "Notes on *Andrena*." *Trans. Am. Ent. Soc.*, 29, pp. 239–258, 1903.
H. L. Viereck and T. D. A. Cockerell, "N. A. Bees of the Genus *Andrena*." *Proc. U. S. Nat. Mus.*, 48, pp. 1–58, 1915.
H. L. Viereck, "New Species of *Andrena*." *Trans. Am. Ent. Soc.*, 43, pp. 365–407, 1917.

[2] W. H. Ashmead, "Classification of the *Nomadidæ*." *Trans. Am. Ent. Soc.*, 26, pp. 64–69, 1899.

so that the latter usually dies of starvation, although both may have sufficient food to complete their development. This family is considered harmful because of the destruction of pollinating species.

FIG. 754.—The panurgid bee, *Calliopsis scutellaris* Fowler. (After Woodworth.)

FIG. 755.—The anthophorid bee, *Diadasia australis* (Cresson). Adult male. (After Woodworth.)

ANTHOPHORIDÆ.[1] Anthophorid Bees.

This is a large family of bees (Fig. 755) which are intermediate in size between the honeybees and the bumblebees, of variable color, but often black, yellowish, brown, or gray, with thick pile and with long tongue or glossa. The males often are pale with the clypeus also pale, while the females are black with the clypeus black. They are all solitary and some species at least build their nests in sand or clay banks and live in large colonies. The cells are provisioned with nectar and pollen. They are valuable as plant pollinators. In the related family of solitary digger bees, *Euceridæ,* the males have very long antennæ.

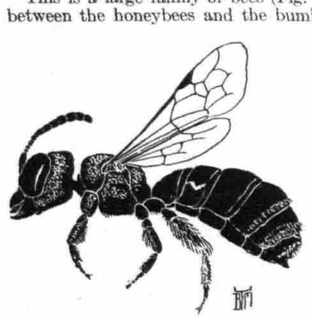

FIG. 756.—The obtuse-tongued bee, *Hylæus conspicua* (Metz.) (After Woodworth.).

HYLÆIDÆ (*Prosopidæ*).[2] Obtuse-tongued Bees.

These are small slender bees which are wholly black or black with yellow or pale marks, with little hair on the body, and the hind tibiæ without a

[1] W. H. Ashmead, "Classification of *Anthophoridæ.*" *Trans. Am. Ent. Soc.*, 26, pp. 58–64, 1899.

T. D. A. Cockerell, "N. A. Bees of the Family *Anthophoridæ.*" *Trans. Am. Ent. Soc.*, 32, pp. 63–116, 1906.

[2] W. H. Ashmead, "Classification of *Prosopidæ.*" *Trans. Am. Ent. Soc.*, 26, pp. 95–96, 1899.

C. W. Metz, "A Rev. of the Genus *Prosopis* in N. A." *Trans. Am. Ent. Soc.*, 37, pp. 85–156, 1911.

distinct pollen brush (Fig. 756). They nest in the ground, in the hollow stems of plants, and provision the cells with nectar and pollen. They also extract the pith from various plants to make their nests. This is a small family of beneficial species.

COLLETIDÆ.[1] Obtuse-tongued Burrowing Bees.

This family comprises small or medium-sized short-tongued, rather hairy, sombre colored bees, the females of which always have a distinct pollen brush on the hind tibiæ. They nest in large colonies in sandy or clay banks or in stone walls and provision the cells with nectar and pollen. The family is beneficial.

FIG. 757.—Cells of the mason bee, *Anthidium consimile* Davidson, attached to twigs of plum tree. (Natural size.)

MEGACHILIDÆ.[2] Leaf Cutting Bees or Megachilid Bees and Mason or Pottery Bees.

The bees of this family are small to medium-sized, black, brown, gray or metallic green, blue, or purplish in color. Some have yellow markings. They have a long tongue or glossa and sharp mandibles. The nests are built in rotten wood or in holes in solid wood, in the hollow stems of plants, attached to stones or twigs, or in the soil. The nests are lined with ovals or circles cut from the leaves of roses and many other plants (Fig. 760). The cells may be placed end to end in series, separated by circular discs, and provisioned with nectar-pollen paste. The pollen for this purpose is carried on the underside of the abdomen. The sharp mandibles work like scissors and they cut out the discs from the leaves in a remarkably short time. Some species use clay instead of leaves to build their nests and are known as mason bees. Still others use resin in cementing the nest linings and are known as "resiniers." Other members of the family are parasitic on the leaf cutting bees. Pulvilli are present between the claws of the mason bees and absent in the leaf cutters. This large family has many

[1] T. D. A. Cockerell, "*Colletes* Found in New Mexico." *Ann. Mag. Nat. Hist.*, 19, pp. 39–52, 1897.

W. H. Ashmead, "Classification of *Colletidæ*." *Trans. Am. Ent. Soc.*, 26, pp. 93–95, 1899.

M. H. Swenk, "Specific Characters in the Bee Genus *Colletes*." *Univ. Stud. Nebr.*, 8, pp. 43–102, 1908.

[2] W. H. Ashmead, "Classification of the *Megachilidæ*." *Trans. Am. Ent. Soc.*, 26, pp. 71–78, 1899.

T. D. A. Cockerell, "Genus *Megachile* in New Mexico." *Ann. Mag. Nat. Hist.*, 6, pp. 7–19, 1900. "Names Applied to Genus *Osmia* in N. A." *Proc. U. S. Nat. Mus.*, 42, pp. 215–225, 1912. "New Mexican Species of *Anthidium*." *Ent. News*, 29, pp. 220–223, 1897. "New *Osmia* from New Mexico." *Can. Ent.*, 29, pp. 65–66, 1897. "New *Osmia* from California." *Can. Ent.*, 21, pp. 120–122, 1910.

H. L. Viereck, "*Megachile* in Alaska." *Ent. News*, 12, p. 325, 1901.

E. S. G. Titus, "New *Osmiinæ* in U. S." *Proc. Ent. Soc. Wash.*, 6, pp. 98–102, 1904; *Jour. N. Y. Ent. Soc.*, 12, pp. 22–27, 1904.

Chas. Robertson, *Trans. Am. Ent. Soc.*, 29, pp. 163–175, 1903.

A. J. Snyder, "Work of Leaf Cutter Bees in Idaho." *Ent. News*, 21, pp. 86–87, 1910.

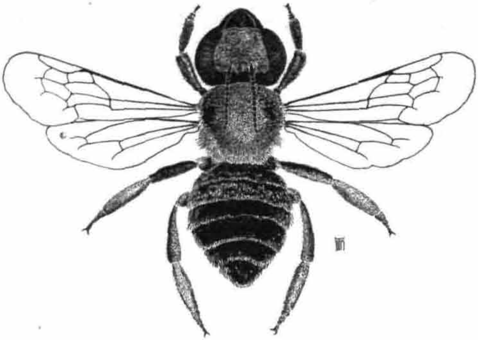

FIG. 758.—The leaf cutting bee, *Megachile latimanus* Say, which pollinates alfalfa in British Columbia and Canada. (After Woodworth.)

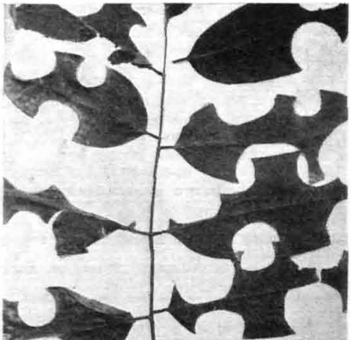

FIG. 759.—Work of leaf cutting bees on leaves of locust tree. The removed portions were used to line the nests and make the cell partitions.

representatives in the Western States, but there is little exact information regarding their habits. Most species pollinate plants and the great good they do in this way far outweighs the slight damage in cutting the leaves of plants.

Anthidium emarginatum (Say) (*Megachile emarginata* Say)[1] is 9 mm. long, densely hairy, black, with white dots on the prothorax and yellowish white fascia near the posterior margin of each abdominal segment, the tibiæ with a pale yellow line on the outside edge. This species nests in holes which are several inches deep in clay banks, sandstone cliffs, stone walls, old wood, or in hollow stems of plants. The burrows are lined with pappus or down from plants, the cells provisioned with nectar-pollen, and the top tightly packed with pappus or flowers so as to be water proof. Each burrow may contain from 1–7 cells partitioned with pappus. This species ranges from the middle States westward into New Mexico, Arizona, and California. The nests frequently also harbor parasites including, in addition to those mentioned elsewhere, *Mutilla unicolor* Say. *Anthidium illustre* Cresson is 12–14 mm. long, opaque black, with short ochraceous pubescence and with pale yellow markings including a broad band on the dorsum of the first five abdominal segments and the sixth segment yellow with two black dorsal spots. The nests are built in holes in the ground and are often in deserted nests of other bees. The cells are lined with pappus from composite flowers and from the down of various plants and insect galls. Two to four cells occur in the cylindrical burrows which may be 8 mm. in diameter and 20 mm. long.[2] This species is recorded from Colorado and Nevada. *A. consimile* Davidson is 7 mm. long and black with yellow markings. It builds its nests in crotches or branches of trees, in crevices in rocks, or in the ground. The cells (Fig. 757) are placed singly or in irregular masses of six or seven, side by side, and covered with comparatively large grains of sand or small pieces of rock. The cells are stored with pollen. They are frequently found in the orchards of the Sierra foothills of California, and also occur in the southern part of the State.

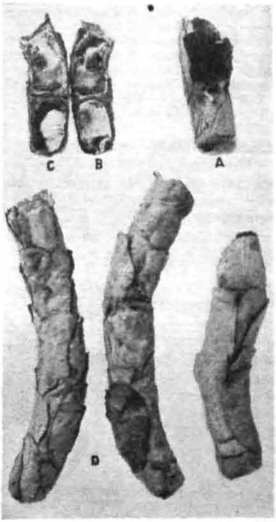

Fig. 760.—Nests of the leaf cutting bee, *Megachile perihirta* Cockerell, removed from the soil. A, cells with portion of top cell removed; B, cross section of two cells showing stored food; C, cross section of two cells showing food and larva; D, series of cells as removed from the soil.

Megachile lippiæ (Cockerell) (*M. cleomis* Ckll. var. *lippiæ* Ckll.) is 11–14 mm. long, black with grayish white pubescence, and characterized by two transverse white areas at the front of the scutellum. Some forms are nearly all whitish. This species is common in New Mexico and Arizona and has been recorded as injurious to young fruit trees in the latter State.[3] *Megachile calogaster* Cockerell and *M. perihirta* Cockerell (Fig. 760), are important beneficial species in the pollination of alfalfa in British Colum-

[1] A. Davidson, *Ent. News*, 6, pp. 252–253, 1895.
[2] S. A. Johnson, *Ent. News*, 15, p. 284, 1904.
[3] A. W. Morrill, "*Jour. Econ. Ent.*," 6, p. 425, 1913; *Fifth Ann. Rept., Ariz. Com. Agr. and Hort.*, p. 33, 1913.

bia.[1] The former lacks the white pubescent bands at the apices of the abdominal segments, segments 3 to 5 are wholly black, and the female has a bright red pollen brush; the latter has white bands on the apices of segments 3 and 4 and sometimes on 5, and the female also has a bright red pollen brush. The latter species nests in colonies in gravelly places. Another species, *Megachile latimanus* Say (Fig. 758), has similar habits in British Columbia and Canada.

The mason bee, *Andronicus productus* (Cresson) (*Alcidamea producta* Cress.), is 7 mm. long, black, spotted with short whitish pile which covers the abdomen, but interrupted with black on the middle dorsum. In this species the pulvilli are present. It builds cylindrical nests often 6 inches long in hollow twigs or excavates the pith and crowds a number of cells at the bottom partitioning them with layers of clay and pith with a long space between the top cell and the walled-up entrance. This bee is also recorded as a guest in the nests of *Anthidium consimile* Davidson. It is parasitized by *Stelis sexmaculata* Ashmead, which according to A. Davidson,[2] attacks 5 per cent of the species, by *Sapyga aculeata* Cress., which attacks 7½ per cent, and by *Agrothereutes albitarsis* (Cresson) which attacks 25 per cent. This is the only record of the last named parasite in California.

CERATINIDÆ.[3] Small Carpenter Bees.

This is a family of small bees averaging 6 mm. in length, rather slender, metallic green, blue, purple, or rarely black (Fig. 761). They build their

FIG. 761.—The small carpenter bee, *Ceratina acantha* Provancher. (After Woodworth.)

nests in hollow stems and reeds or hollow out the pith in rosaceous plants, elders, and so forth, and make a series of cells provisioning them with nectar-pollen and partitioning them with pith or plant fibre. An egg is laid in each and hatching begins from the bottom up, the adults eating through the partition immediately above and awaiting the emergence of

[1] F. W. L. Sladen, "Pollination of Alfalfa by Bees of the Genus *Megachile*." *Can. Ent.*, 50, pp. 301–304, 1918.

[2] A. Davidson, *Ent. News*, 7 pp. 216–218, 1896.

[3] W. H. Ashmead, "Classification of the *Ceratinidæ*." *Trans. Am. Ent. Soc.*, 26, p. 69, 1899.

H. S. Smith, Contribution towards A. Monograph of the *Ceratinidæ* of North and Middle America." *Trans. Am. Ent. Soc.*, 33, pp. 115–124, 1907.

the top and last member in order to escape together with the mother which awaits her young in the space above the top cell. Some species then clean out the burrows and a second brood is reared, there being two broods a year. The adults of the last brood remain in the cells during the winter and emerge the following spring. The members of this family are beneficial as pollinators.

XYLOCOPIDÆ. [1] Large Carpenter Bees.

These are very large robust bees somewhat resembling bumblebees, but lacking the characteristic yellow markings. The females, moreover, have a dense brush of hairs on the hind legs instead of a pollen basket. The color is usually metallic blue-black with green or purplish reflections, but the males in certain species are entirely or partially buff or pale yellow. The males can be separated from the females as they have 13-jointed antennæ and the females 12; 1 spine at the tip of the hind tibiæ while the females have 2; 7 exposed abdominal segments, while the females have 6. The males have only 2 teeth at the apex of the mandibles, while the females have 2 at the apex and also on the upper margins. The females also have a triangular row of spines on the dorsum of the last abdominal segment not present in the males. In excavating their burrows in dry wood, they are often destructive to building timbers and telephone poles which are thus greatly weakened.

The mountain carpenter bee, *Xylocopa orpifex* Smith,[2] is 12–17 mm. long and black in both sexes. The females have the abdominal segments faintly carinated and the males have the head and pronotum covered with white or yellow hairs mixed with the black. The species prefers sound Douglas fir, redwood, and other timbers, and makes burrows which are first straight and then turn upwards, varying from 5 to 12 inches in length. Exposed timbers in bridges and buildings, fence posts, or telephone poles are attacked. Many of the bees may colonize close together. The burrows are then provisioned with honey-pollen or bee bread, an amount about the size of the body constituting a cell in which a single egg is laid, and then the burrow partitioned with chips of wood cemented together in a spiral disc. Thus from 5–6 cells may be constructed in a week and the larvæ feed from 22–28 days, rest 15–19 days, and then pupate. When mature they are yellowish white, robust, and 7 mm. long. Pupation requires about 15 days after which the adults emerge. This species occurs chiefly in the foothills and mountains of Lower California, Arizona, California, Nevada, and Oregon, and is quite common in some sections. Among the natural enemies in addition to those listed elsewhere are [3] the bombylid flies, *Spongostylum delila* (Loew) and *S. simson* (Fabr.). The tenebrionid beetle, *Aphanotus brevicornis* (Lec.), is also recorded from the cells in Southern California but may feed only on the stored bee bread.

[1] W. J. Fox, "California Species of *Xylocopa*." *Ent. News*, 3, p. 17, 1892.
W. H. Ashmead, "Classification of *Xylocopidæ*." *Trans. Am. Ent. Soc.*, 26, pp. 70–71, 1899.
A. J. Ackerman, "U. S. Species of *Xylocopa*." *Jour. N. Y. Ent. Soc.*, 24, pp. 196–232, 1916.
[2] H. H. Nininger, *P. C. Jour. Ent. and Zoöl.*, 8, pp. 158–164, 1916.
[3] A. Davidson, *Ent. News*, 4, pp. 151–153, 1893.

The valley carpenter bee, *Xylocopa varipuncta* Patton [1] (Fig. 762), is 18–20 mm. long, and robust. The females are metallic black with brilliant violaceous, brassy, or bronzy reflections, and the males golden brown or buff throughout. This species prefers partially decayed live oak, deciduous oaks, pepper, eucalyptus, and other hardwood trees, and makes burrows 5–12 inches long which may or may not be straight, but which follow the grain of the wood. Several burrows may have a common entrance. It occurs more often in the valleys and lower foothills of Lower California,

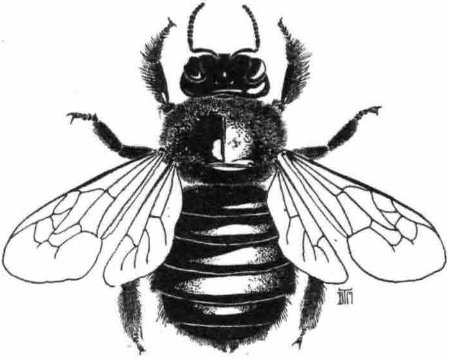

FIG. 762.—The valley carpenter bee, *Xylocopa varipuncta* Patton. Adult female. (After Woodworth.)

Arizona, and California. A mite, *Trichotarsus xylocopæ* Donn.? was found attacking the larvæ in the brood cells by Nininger.

The Arizona carpenter bee, *Xylocopa arizonensis* Cresson, is 15–20 mm. long, both sexes brilliant metallic blue, with fuliginous or almost opaque wings. The male has white hairs only on the sides of the first abdominal segment. It ranges from Mexico into Texas, New Mexico, and Arizona.

The California carpenter bee, *Xylocopa californica* Cresson, is 20–24 mm. long, both sexes black with green or blue reflections and dusky wings. It closely resembles the Arizona carpenter bee, but the pronotum of the male has white, yellow, or orange pile, the entire first abdominal segment has whitish hairs, and the wings are not so opaque. It is recorded in Colorado, Nevada, and California, and probably has a much wider range.

APIDÆ.[2] Bumblebees or Humblebees and Honeybees.

This family comprises the well known, medium-sized or large, densely hairy or pubescent, long-tongued bees which live in large, well organized communities consisting of sexual females or queens, abortive females or

[1] H. H. Nininger, *P. C. Jour. Ent. and Zoöl.*, 8, pp. 164–165, 1916.
[2] H. L. Viereck, *Hym. Conn.*, pp. 745–760, 1916.

workers, and sexual males or drones. Queens and workers originate from fertilized eggs, the latter without sexual development, while the males arise from infertile eggs. The workers are equipped with a sting which serves as a good means of defense, the sting of the queen is for killing rivals or is useless, and there is no such organ in the drones. These bees are among the most beneficial of insects because they furnish the only natural means of pollination of a great variety of economic plants. The honey in addition is a valuable article of commerce so that apiculture is an important industry in this and other countries.

Among the bumblebees are some guest species which live entirely at the expense of the host.

The bumblebees are now placed in the genus *Bremus* more familiarly known in the past as *Bombus*, the latter name becoming obsolete because of the priority of the former. The bees are still retained in a separate family, *Bombidæ*,[1] by most students. They are medium to large-sized, robust, densely hairy, black and bright yellow or rarely red, species characterized by having two apical spurs on the hind tibiæ and a single submarginal cell in the fore wings. The large fertilized queens hibernate in hollow trees, refuse, or in the ground, and appear in the spring. They seek a suitable nesting place in a deserted rodent's hole or make one for themselves and start the new colony by gathering pollen and nectar and storing it in the nest. When sufficient has been accumulated eggs are laid on the paste-like mass and the white legless larvæ soon appear and feed throughout the paste, no cells being provided for the young by the queen. While these first larvæ are developing the mother continues to provision the nest and lay eggs. Soon the very much smaller workers begin to appear and there is new life about the nest. They enlarge the burrow, gather food, and construct brood cells, thus relieving the queen of all duties except egg laying. Thus the nest soon becomes a large community occupying a deep or shallow hole from 8–12 inches in diameter lined with straw or bits of dry plants, and with one or more entrances. The cells are mostly for the brood, each containing from one to several larvæ, but some are stored with pollen and others with honey. There may be large and small workers, but none of them equals in size the large hibernating queens. Sexes appear in the fall and mate. The males and workers gradually perish with the approach of winter and the fertile females or queens seek hibernating quarters. Because of their very long tongues bumblebees are able to pollinate clovers, alfalfa, and many other blossoms which ordinary bees cannot, and are necessary for the production of seed of such crops. Thus it is impossible to grow certain varieties of red clover seed where bumblebees or other long-tongued bees do not occur. There are a large number of western species, all of which cannot be included in this brief account. The arrangement follows that of H. J. Franklin.

The western bumblebee, *Bremus occidentalis* (Greene) (*Bombus*, *B. modestus* Cress., *B. proximus* Cresson, *B. howardi* Cress.). Queens 15–

[1] W. H. Ashmead, "Family *Bombidæ*." *Trans. Am. Ent. Soc.*, 26, pp. 57–58, 1899,
C. Robertson, "Syn. *Bombinæ*." *Ibid.*, 29, pp. 176–182, 1903.
H. J. Franklin, "New N. A. *Bombidæ*." *Ibid.*, 37, pp. 157–168, 1911. "*Bombidæ* of the New World." *Ibid.*, 38, pp. 177–486, 1912. Complete.
T. H. Frison, "Notes on *Bombidæ*," etc. *Ann. Ent. Soc. Am.*, 10, pp. 277–286, 1917.

18 mm., males 11.5–15.5 mm.; workers 9.5–15 mm.; mandibles strongly four-toothed; vestiture or pile of medium length, face with yellow pile below the antennæ; thorax variable but the anterior dorsum and sides yellow, a broad black band between the bases of the wings; scutellum with mixed yellow and black pile; wings infuscated with black veins; legs black, tarsi brown; corbicula or pollen basket golden yellow; abdomen variable, always black at the base, black or yellow near the middle, and whitish ferruginous at the posterior tip which frequently has a yellow band just in front. The workers and queens are very similar in color but the males have more yellow and whitish pile. The subspecies *nigroscutatus* Franklin has the scutellum entirely black. This is a very common species throughout boreal western North America and occurs in every Western State, ranging from Arizona and New Mexico northward into Canada and Alaska, along the eastern slopes and plains of the Rocky Mountains and westward to the Pacific Ocean. It has been known to puncture the flowers of Chinese cabbage (*Cruciferæ*) in British Columbia to secure the nectar, because the tongue was too short to reach it in the normal way.[1]

The mountain bumblebee, *Bremus appostius* (Cresson) (*Bombus*). Queens 14–20 mm.; males 12–17 mm.; workers 10–14 mm.; abdomen tapering very gradually towards tip; black, most of the head and dorsum of the thorax clothed with whitish pile; black between the bases of the wings; scutellum tawny or bright orange; first five segments of the abdomen tawny or orange above, venter and apex black. The workers are often almost wholly saffron yellow above. This is a fine large beautiful species which inhabits the higher mountains and valleys of boreal western North America and is recorded in all the Western States excepting Arizona. The northern limits are British Columbia and western Canada. It is replaced in the east by *B. borealis* (Kirby), which ranges west to the Rocky Mountains.

Kirby's bumblebee, *Bremus kirbyellus* (Curtis) (*Bombus*, *B. putnami* Cress.). Queens 15–19 mm.; males 12–16 mm.; workers 11–15 mm.; clothed with long fine pile; head long and triangular; head of females black, of males with yellow patch on face below antennæ; thorax wholly yellow except black band between bases of wings; wings pale; abdomen yellow at base, black in middle, and yellow or reddish at apex. This is a boreal species occurring in Siberia and boreal North America and ranging south along the Rocky Mountains into New Mexico and along the Pacific Coast from Alaska into Oregon.

Edward's bumblebee, *Bremus edwardsi* (Cresson) (*Bombus*, *B. bifarius* Cress., *B. cooleyi* Morrill, *B. vancouvrensis* Cress.). Queens 13–17 mm.; males 10–12 mm.; workers 9–12 mm.; pile coarse and of medium length; black; face and occiput, pronotum, the sides and part of the dorsum of the mesothorax, two spots on the scutellum, the first four abdominal segments and a band near the tip bright yellow; two apical segments black; corbicular fringes reddish. The color varies to a considerable degree especially the yellow on the abdomen, and many have the dorsal second and third segments reddish in the southern limits, and others mostly black in the northern. The species is boreal and occurs in Alaska, British Columbia, Washington, Idaho, Montana, Wyoming, Colorado, Utah, New Mexico, Nevada, California, and Oregon. In the southern limits it is confined to the mountains.

Fernald's bumblebee, *Bremus fernaldi* (Franklin) (*Bombus*), is similar in size and coloration to the preceding species, but is separated by the dark corbicular fringes and the straight hind border of the black band between the wings, and by the entirely black scutellum. The base of the abdomen has the first segment yellow and the second and third as a rule wholly black, the fourth and fifth yellow, and the apex black. It occurs in middle California ranging from the coast to the high Sierras and into Nevada.

[1] J. W. Cockle, *Can. Ent.* 45, p. 347, 1913.

The yellow-faced bumblebee, *Bremus vosnesenskii* (Radoszkowski) (*Bombus*) (Fig. 763). Queens 14–19 mm.; males 10–14 mm.; workers 9–14 mm.; pile short and thick; black, face, occiput, pronotum, and the mesonotum in front of the wings and the dorsum of the fourth abdominal segment yellow. This is the commonest species in many parts of California and ranges south into Lower California, east into Nevada, and north into

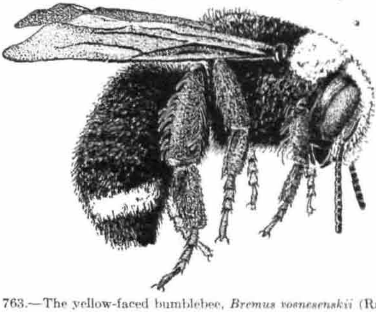

FIG. 763.—The yellow-faced bumblebee, *Bremus vosnesenskii* (Rad.).

Oregon, Washington, and British Columbia. It has often been confused with *B. californicus* (Smith).

The red-banded bumblebee, *Bremus melanopygus* (Nylander) (*Bombus*, *B. lacustris* Cress.). Queens 15–18 mm.; males 9–13 mm.; workers 11–15 mm.; pile quite long and fine; head, and dorsum of thorax to scutellum of mixed and clouded black and yellow color; scutellum and pleura yellow; first abdominal segment yellow, second and third fiery red, fourth black and yellow, fifth and sixth black; corbicular fringes black or reddish. The species is arctic, common in Southern Alaska and Western Canada and ranging south into British Columbia, Washington, Oregon, Idaho, Montana, Wyoming, Utah, and Colorado.

The frigid bumblebee, *Bremus frigidus* (Smith) (*Bombus*). Queens 13–16.5 mm.; males 10–12 mm.; workers 9–12 mm.; pile long and fine, face of females black, of males yellow; thorax wholly yellow except broad black interalar band, dorsum of abdomen yellow at base, black in middle and yellow or reddish at apex; corbicular fringes reddish. This species occurs throughout arctic North America and ranges west into Alaska and south in the high mountains into British Columbia, Washington, Idaho, Montana, Wyoming, Colorado, and New Mexico.

The pale-faced bumblebee, *Bremus flavifrons* (Cresson) (*Bombus*, *B. alaskensis* Ashm.). Queens 13–16 mm.; males 11–12 mm.; workers 9–12 mm.; pile medium and coarse; black, face, and occiput largely yellow; dorsum of thorax with mixture of yellow and black, mesopleura yellow to coxæ, dorsum of abdomen with first and second segments yellow, third and fourth variable, fifth and sixth black; corbicular fringes entirely black or partly reddish. This is a boreal or arctic species ranging from Alaska into British Columbia, Washington, Oregon, California, Nevada, Idaho, Utah, Montana, Wyoming, Colorado, and New Mexico.

The mixed bumblebee, *Bremus mixtus* (Cresson) (*Bombus*), is very similar to the preceding species in size and color. The face is yellow; occiput and dorsum of the thorax to scutellum mixed yellow and black, interalar band black with indefinite margins, scutellum yellow, pleura yellow to legs, dorsum of abdomen yellow at base, black in middle, yellowish red at apex; corbicular fringes reddish. The distribution is the same as that of the preceding species.

The Sitka bumblebee, *Bremus sitkensis* (Nylander) (*Bombus*, *B. oregonensis* Cresson). This species is very similar to *B. mixtus* (Cresson), from which the females can readily be separated by the longer pile and dark scutellum. It occurs in Alaska and Western Canada and ranges south along the mountains into Washington, Oregon, California, Idaho, Montana, and Wyoming.

The yellow bumblebee, *Bremus fervidus* (Fabr.) (*Bombus*). Queens 15–21 mm.; males 10–16 mm.; workers 8–15 mm.; pile of medium length and coarse; head triangular, black; thorax mostly yellow, sometimes with interalar black band; dorsum of abdomen with first four segments yellow and last two black, venter and legs black; wings strongly infuscated. This species occurs throughout the United States, except the Gulf States and Canada, and occurs over the entire west. Larvæ of *Ephestia kuehniella* Zeller, and the tachinid fly, *Brachycoma davidsoni* Coq. and *Mesostenidea thoracica* (Cresson), have been reared from the nests by A. Davidson in Southern California.[1] This species is close to *Bremus pennsylvanicus* (DeGeer), in the east, with which it has frequently been confused.

The California or black-faced bumblebee, *Bremus californicus* (Smith) (*Bombus*, *B. dubius* Cress.). Queens 15–22 mm.; males 12–16 mm.; workers 9–15 mm.; pile moderately long and coarse; black with the head entirely black, front part of the dorsum yellow; dorsum of abdomen usually has only the fourth segment yellow, but in some rare worker variants the abdomen is entirely black and in a few queens and male variants there is considerably more yellow on the abdomen. This is a boreal species ranging throughout the western part of North America from the eastern slopes of the Rocky Mountains to the Pacific Ocean and from Alaska to Mexico. It is very common in California and has often been confused with *B. vosnesenskii* (Rad.) and with *B. fervidus* (Fabr.).

The Nevada bumblebee, *Bremus nevadensis* (Cresson) (*Bombus*, *B. improbus* Cress.). Queens 18–22 mm.; males 13–17 mm.; workers 15–18 mm.; pile short and dense; black, head of females black, face and occiput of male yellow, dorsum of thorax and the dorsum of the first three abdominal segments yellow, the tip of the abdomen of the females black, of the males reddish. This species occurs throughout boreal western North America from the Rocky Mountains to the Pacific Ocean and from Alaska to Mexico.

The false or guest bumblebees belonging to the genus *Psithyrus*[2] are generally mistaken for the true bumblebees because of the remarkable resemblance. They are distinguished by the absence of the corbiculæ or pollen baskets; small eyes; untoothed mandibles of the females; slender evenly haired hind tarsi; abdomen of female usually bent downward and forward and with little pile on the dorsum. These bees live as guests or inquilines in the nests and at the expense of the true bumblebees, which accounts for the differences in structure and apparent specialization. There are no workers, only the sexual females and males being represented. The queens appear shortly after those of the host in the spring and enter and lay eggs in the nests of the bumblebees. Many are stung to death if detected by the host. *Psithyrus insularis* (Smith) is probably the best known western species. The females are 13.5–18 mm. long, yellow and black, the face yellow between and above the base of the antennæ, dorsum of thorax yellow with interalar band or spot black, pleura yellow to legs, dorsum of abdomen black, usually with yellow on the sides of the second, third, fourth, and fifth segments. The species victimizes *Bremus*

[1] *Ent. News*, 5, pp. 170–172, 1894.
[2] H. J. Franklin, "The Genus *Psithyrus*." *Trans. Am. Ent. Soc.*, 38, pp. 447–477, 1912.

flavifrons (Cresson) [1] in the west and occurs in New Mexico, Colorado, Utah, Wyoming, Montana, Nevada, Idaho, California, Oregon, Washington, British Columbia, and Alaska. *Psithyrus consultus* Franklin is a very closely allied species having practically the same distribution. The dorsum of the abdomen beyond the third segment bears yellow pile. *P. bicolor* Franklin is also similar to *P. insularis* (Smith), but has the lower halves of the pleura black. It occurs in New Mexico. *P. crawfordi* Franklin has the dorsum of the head and thorax and the apical half of the dorsum of the abdomen yellow. It occurs in California and Oregon. *P. variabilis* (Cresson) is 13–17 mm. long, occiput of the head and part of the dorsum of the thorax yellow, and the abdomen entirely black in the female and variable in the male. It occurs in the nests of *Bremus pennsylvanicus* (De-Geer) in the east, and ranges west into Texas and New Mexico. *Psithyrus latitarsus* Morrill is 15–19 mm. in length, head mostly black, dorsum and sides of thorax mostly yellow, and the dorsum of the abdomen with scattering yellow pile. It ranges in Mon-

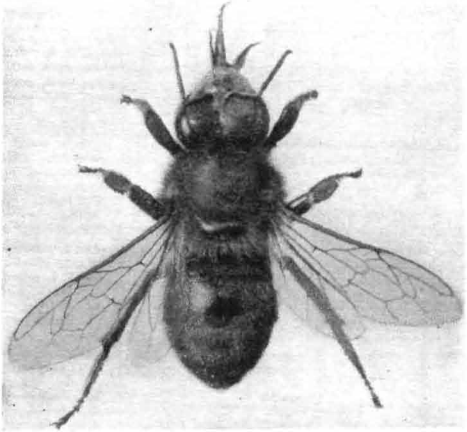

FIG. 764.—The honeybee or hivebee, *Apis mellifica* Linn. Worker.

tana, Washington, and British Columbia. *P. suckleyi* (Greene) is 13–14 mm., occiput of head yellow, dorsum and pleura of thorax mostly yellow, dorsum of abdomen with first segment yellow, second yellow in middle, third is wholly or partly yellow, fourth mostly yellow, fifth and sixth yellow on sides, seventh dark, sides mostly yellow. This species occurs throughout the northern parts of the west ranging from Northern California, Nevada, Utah, and Colorado into western Canada and British Columbia. *P. fernaldæ* Franklin is 12–16 mm. long and similar to the preceding species in markings, but has the dorsum of the fifth abdominal segment with considerable reddish pile. It is a boreal species ocurring throughout the northern United States and Canada, with Colorado, Utah, Nevada, and northern California as the southern limits in the west. *P. tricolor* Franklin is very close to if not identical with *P. fernaldæ* Franklin and has practically the same range.

[1] T. H. Frison, *Can. Ent.*, 53, p. 100, 1921.
O. E. Plath, *Biol. Bul.*, 43, p. 23, 1922.

The honeybee or hivebee, *Apis mellifica* Linn. (*A. mellifera* Linn.)[1] (Figs. 764, 765). Queens elongated, 15–20 mm.; drones robust 15–17 mm.; workers 11–15 mm.; mostly various shades of brown and black; the head, antennæ, legs, and portions of the abdomen dark; body clothed with dense short buff or pale pile which is thickest on the thorax and thinnest on the dorsum of the abdomen. This highly social insect lives in large colonies of from 20,000 to 50,000 individuals and has been somewhat domesticated. Wild swarms occur in practically all places where bees are kept.

RACES.

There are many races, the four most important ones used in America are characterized as follows:[2]

Races	*Color of Abdomen*	*Disposition*	*Production*	*Color of Cappings*	*Remarks*
ITALIAN	Variable. Dark or with from 3–5 yellow bands	Gentle	Very best	Nearly white	Most popular in America and in the west. Build few queen cells. Do not run over comb. Keep out wax moth. Most *resistant to European* foul brood.
CAUCASIAN	Black, gray or with yellow bands	Gentlest. Hybrids are cross	Good	White	Used to some extent in America. Use large amounts of propolis. Dark queens hard to distinguish. Very susceptible to European foul brood.
CARNOLIAN	Gray to blackish. Abdominal segments margined posteriorly with white hairs.	Gentle	Good	White	Losing ground in America. Swarm excessively. Build numerous queen cells. Claimed to be resistant to European foul brood.
GERMAN	Black	Cross, but respond to smoke	Poor to medium	White	Condemned by best American beekeepers. Less prolific than Italians. Run badly over combs and do not keep hives clean. Do not keep out wax moth. Very susceptible to European foul brood.

None of the above races are really resistant to the American Foul Brood.

[1] F. Benton, "Specific Name of the Common Honey-Bee." *Proc. Ent. Soc. Wash.*, 6, pp. 71–73, 1904.

R. E. Snodgrass, "Anatomy of the Honey Bee." *Tech. Ser.* 18, Div. Ent. U. S. Dept. Agr. 1910. *Anatomy and Physiology of the Honeybee.* McGraw-Hill Book Co., N. Y., pp. 1–327, 1925.

D. B. Castell, *The Behavior of the Honey Bee in Pollen Collecting.* Bul. 121, Bur. Ent. U. S. Dept. Agr. 1912.

A. I. and E. R. Root, *The A B C and X Y Z of Bee Culture.* A. I. Root Co., Medina, Ohio, 1920.

E. F. Phillips, *Beekeeping.* Macmillan Co., N. Y. 1921.

G. H. Vansell has kindly read and corrected the manuscript dealing with the honeybee.

[2] Modified from E. F. Phillips and W. Lockhead.

CASTES

Queen—fertile female, mother of colony, arises from fertile eggs and larvæ furnished with special food known as royal jelly; has sting which is only used to kill rival queens.

Workers—abortive or neuter females arise from fertile eggs; homemakers of the colony; sting used in self-defense or in defense of the colony.

Drones—sexual males, arising from unfertilized eggs; mate with queens; have no sting.

COMB

The comb consists of two layers of six-sided cells constructed of wax, back to back, and slightly slanting towards the middle partition. The wax is obtained from special glands on the undersides of the abdomen and is masticated and mixed with cephalic gland fluids. It is necessary for the workers to consume 20 pounds of honey to produce

FIG. 765.—The honeybee taking nectar from an almond blossom and showing how cross-pollination is accomplished.

a pound of wax. Propolis is a brownish resinous cement collected most abundantly in late summer and fall from buds and trees and used on rough surfaces, small cracks in the hive, and on portions of the comb.

Honey Comb. The cells which are used for the storage of honey and are usually around the top and sides of the comb. They are capped with wax.

Brood Comb. Cells which occupy the lower and central portions and consist of the following kinds:

(1) Worker—cells similar in size to those used for the storage of honey, containing various stages from the fertilized egg to emerging adult. The mature larvæ spin a thin parchment-like cocoon within the cells, where pupation takes place.

(2) Queen—very large irregularly shaped cells somewhat resembling a small peanut in shape and size and with the opening downward. The number of queen cells in the brood comb depends upon the season, the race, and the necessity for the same.

(3) Drone—cells similar in shape, of the same size or larger in diameter than the worker cells and somewhat longer. Larvæ hatch from unfertilized eggs.

FOOD

The worker larvæ are first fed on certain fluids from the mouths of the nurse workers and later on a mixture of honey and pollen and on water. The larvæ destined to become queens are given throughout the larval period, a thin highly specialized type of food not furnished the others, except during the first two or three days.

Honey. Nectar gathered from plants and elaborated in the honey sac of the workers. It is also made from the honeydew of insects. It is mixed with a small percentage of pollen and is stored as food for the adults, to be used chiefly during the winter or in time of need.

Bee Bread. Pollen collected from the flowers of plants mixed with a little honey. It is used for feeding the young.

Water. Collected directly or extracted from the nectar and used for feeding young and adults.

Royal Jelly. A highly nutritious material which is secreted mostly by young adult workers and which is fed to all very young larvæ. It constitutes the entire food of the larvæ destined to become queens.

LIFE HISTORY

Duration of Stages. These vary somewhat with temperatures. (After Lockhead.)

	Egg	*Larva*	*Pupa*	*Total*
Queen	3 days	5½ days	7 days	15½ days
Drone	3 days	6 days	15 days	24 days
Worker	3 days	5 days	13 days	21 days

Swarming. A departure from the old colony, all of the exact reasons for which are unknown. Among other reasons, however, is the desire to relieve overcrowding and to establish new colonies. This departure usually consists of the old queen and a large following of drones and workers; may occur from none to many times in a season; usually in late spring and early summer and after a new queen and drones appear. The new queen remaining in the old colony stings to death any other young rivals and after a nuptial mating flight in mid air, returns to the hive and continues the egg-laying for the colony.

Mating. Occurs in spring, summer or fall in mid air during the nuptial flight of the queen. *The spermatheca is filled with spermatozoa from the male, there being sufficient* to fertilize all the eggs subsequently laid to produce workers and queens. Queens usually mate but once. Drones may or may not be killed by the workers after mating, or in the late fall or when food is scarce.

ECONOMIC VALUE

Aside from the production of honey and wax, which are of great value in many parts of the United States and particularly so in a number of the Western States, the honeybee is probably of greatest importance to agriculture in the pollination of plants. The benefits thus derived are so far reaching as to be impossible of estimation. In many of the orchards in the west, farmers and beekeepers are coöperating in the use of honeybees to cross pollinate the blossoms of fruit trees, many varieties of which cannot be profitably fertilized in any other manner, and other apparent self-fertilizing varieties are very greatly benefited by the work of the bees.[1] For this purpose one stand of bees is recommended for each acre of mature orchard trees.

[1] W. P. Tufts and G. L. Philip, *Almond Pollination.* Bul. 346, Cal. Agr. Exp. Sta. 1922. *Pear Pollination.* Bul. 373, Cal. Agr. Exp. Sta. 1923.
A. H. Hendrickson, *Plum Pollination.* Bul. 310, Cal. Agr. Exp. Sta. 1919 and 1924.

FIG. 766.—A student notebook collection. Holes of suitable shapes and sizes are made in page-sized double-faced corrugated box paper, and the dried insect specimens placed on a thin layer of cotton in the same. The page is then faced with a name sheet of white paper and covered with gelatine paper, or other transparent material and all is bound with tape. Both sides of the page may be utilized for small specimens, the cotton layer serving as a partition in the cardboard hole. These collections are made by the students and filed in the regular laboratory drawing notebooks. It also shows a few student errors.

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